The 'ingenious' rev. Dr. John Walker: chemistry, mineralogy and geology in enlightenment Edinburgh (1740-1800)

Eddy, Matthew Daniel

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Doctor of Philosophy
Department of Philosophy
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Abstract

Rev. Dr. John Walker (1731-1803) held the Regius Chair of Natural History in the University of Edinburgh's Medical School from 1779 until 1803. As a student of William Cullen, advisor to Lord Kames and friend of Joseph Black, he went on to teach well over seven hundred students and was a founding member of the Royal Society of Edinburgh. This study uses his career to trace the course of the nascent earth sciences within the Medical School's local reality. It is based on the publications of Walker and his colleagues, and on the vast archive of his personal manuscripts, correspondence and lecture notes housed in the University of Edinburgh's Special Collections. After Chapter 1's biographical introduction, Chapters 2 and 3 concentrate on his early chemical education and show that a principle-based form of experimental pharmacology laid the epistemological and methodological foundation for Edinburgh's interest in mineralogy. This is done by examining the Medical School's 1750s chemistry course in relation to Walker's early publications and then by detailing his mid-career tours and attempts at mineralogical taxonomy. Moving on to his time as Professor of Natural History, Chapters 4 and 5 excavate his 'fossil' sources and vocabulary and detail his 1797 mineralogical system. The final chapter gives an account of his geology lectures and how they were directly affected by his conception of chemistry and mineralogy; special attention is given to geological methodology, time, extraneous fossils and testimony taken from classical works. The conclusion proceeds to illustrate how histories interested in the 'forerunners' of the chemical revolution and/or the evolutionary paradigm ignore the large number of chemically trained industrialists and medical professionals who contributed to Enlightenment concepts of the earth's form and structure.

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ILLUSTRATIONS

This thesis has not been previously submitted for a degree in this or any other university.

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DRAMATIS PERSONÆ

Georg Agricola
Charles Alston
Joseph Banks
Joseph Black
Johann Becher
J. D. D. Beale
Thomas Beddoes
Sir Torbern Bergman
Élie Bertrand
Joseph Black
Anna Blackburn
Herman Boerhaave
J. C. Valmont de Bomare
Robert Boyle
Comte de Buffon
Lord Buchan
J. B. M. Buquet
Thomas Burnet
Lord Bute
Lord Cathcart
John Clerk
Emanuel Mendes da Costa
Daniel Coxe
Axel Fredrik Cronstedt
William Cullen
William Creech
Lord Daer
René Descartes
Cornelius Elliot
John Ellis
F. W. P. Fabricius
Daniel Foote
Benjamin Franklin
James Hall
Edmund Halley
William Hamilton
Brian Higgins
Nathaniel Highmore
John Hill
George Home-Drummond
Lord Hopetoun
Robert Horseburgh
James Hutton
Robert Jameson
Lady Kames
Lord Kames
John Keill
Richard Kirwan
Lord Lauderdale
Anton Lavoisier
Charles Leigh
Carl Linnaeus
John Locke
Lord Loudan
André de Luc
Pierre Joseph Macquer
Andreas Marggraf
Scipio des Moulins
Lord Mure
Lord Nairn
John Naysmith
Lord Northumberland
David Pollock
John Playfair
Pliny the Elder
Joseph Priestley
Andrew Plummer
Johann Heinrich Pott
John Pringle
Lord Queensbury
Robert Ramsey
John Ray
John Rogerson
Karl Wilhelm Scheele
Giovanni Antonio Scopoli
Fredrick Slare
James Edward Smith
Georg Ernst Stahl
John Walker
Johan Gottschalk Wallerius
William Watson
William Whiston
John Whitehurst
John Williamson
Alexander Wight
Edward Wight
William Withering
Robert Wittie
William Wright
John Woodward

JOHN WALKER TIMELINE

1731	Born, Canongate, Edinburgh.
1740s	Attends Canongate Grammar School (of his father) and learns Latin and Greek.
1741	Reading Homer and Sutherland's *Hortus Edinburgensis.*
1746	Begins to collect minerals. Enters Edinburgh University.
1749	Receives his divinity degree.
1750	Tours Lothian and Tweedale.
1753	Goes to Galloway
1754	Licensed to preach in Kirkcudbright. *Circa* this year he joins the Philosophical Society.
1757	Reads first scientific paper, 'An Account of a New Medicinal Well Discovered in Moffat'.
1758	Tours Highlands with Cullen. Called to first post in Glencorse. Publishes his first *Philosophical Transactions* article Meets Kames.
1759	Meets Benjamin Franklin, who was visiting Lord Kames
1762	Transferred to Moffat. Writes 1st letter to Linnaeus. Sponsors Linnaeus's election to the Philosophical Society against strong resistance.
1764	First Hebrides Trip (May-December). Travels in Highlands with Cullen.
1765	Receives an honorary MD from Glasgow and a DD from Edinburgh.
1766	Begins to write his *Adversaria*
1771	Recommissioned to go back to the Hebrides.
1772	Returns from 2nd Hebrides trip and reports to the General Assembly Publishes second *Philosophical Transactions* article
1779	Appointed Regius Chair of Natural History and Keeper of the University Museum.
1781	Writes *Schediasma Fossilium.*
1782	Writes *Delineatio Fossilium* and *Fragementa Calendarii Florii Edinburgensis.* Helps found Natural History Society of Edinburgh. Reads 1st Natural History course. Nominated by Lord Lauderdale to Colinton.
1783	Appointed Secretary of the Physical Section of the Royal Society of Edinburgh. Transferred from his parish in Moffat to one in Colinton.
1787	Publishes *Classes Fossilium.*
1788	Publishes in 1st *Transactions of the Royal Society of Edinburgh.*
1789	Marries Jane Wallace Wauchope.
1790	Gives agricultural lectures (first in English language). Elected Moderator of the General Assembly
1791	'A Sermon Preached before His Majesty's High Commissioners'.
1792	Helps form the Agricultural Society of Edinburgh. Unsuccessful bid to be the Professor of Agriculture. Publishes *Institutes of Natural History.*
1799	Publishes several articles in *Prize Essays and Trans. High. Soc. Scot.*
1803	Walker dies. Posthumous essays published in *Prize Essays and Trans. High. Soc. Scot.*
1808	Charles Stewart publishes *Essays on Natural History and Rural Economy*
1812	*Essays on Nat. Hist. and Rural Economy* republished
1827	Jane Wallace Wauchope dies.

Introduction

The Rev. Dr. John Walker served as the University of Edinburgh's Regius Chair of Natural History from 1779 to 1803. In this capacity he taught over 700 students, foreign and British, and was a central figure in Enlightenment Scotland's intertwined culture of medicine, natural philosophy and natural history. Although he wrote and lectured on a wide variety of topics, the main purpose of this thesis is to examine how chemistry and mineralogy laid the foundation for his geological conception of the earth's composition and structure. More specifically, I use Walker's career to argue that *the nascent earth sciences in Enlightenment Edinburgh were founded on the empirical methodology and epistemology used by the experimental chemists who taught in the Medical School.* The main source material for this study is the vast Walker archive housed in the University of Edinburgh's Special Collections Department. It consists of over fifty sets of bound manuscripts and several boxes full of personal observations, correspondence, bills of sale and student class lists. In conversation with these sources, I consulted many eighteenth-century books and articles that were either held in Walker's library or mentioned in his lectures. Although most of these works were widely read during the Enlightenment, some of them are very hard to find today (for some there were only one or two extant copies). Even so, in most cases, I took great care to consult the specific edition used by Walker and to give the list number of each book as it appeared in the posthumous catalogue made of his library.

As such a narrowly defined work of scientific biography, the parameters of my research were influenced by the methodology employed by David Knight in his work on Humphry Davy and in his essays on historical sources.[1] By digging into a scientist's mental bookshelf, personal beliefs and empty pocket book, Knight places the humanity of existence alongside newly emerging conceptions of the natural world. In addition to Knight's approach, I fine tuned my focus by employing Roy Porter and Mikulás Teich's emphasis upon national context and Nicholas Jardine's conception of a 'local reality'. Over two decades ago, Porter asserted that, 'With few exceptions, historians of science have paid little attention to a major branch of natural philosophy

[1] D. M. Knight, *Humphry Davy: science & power* (Cambridge: 1998). *Sources for the history of science 1660-1914: Studies in the uses of historical evidence* (London: 1975). Further approaches can be also be seen in the current scientific biography series published by Cambridge University Press and in Michael Shortland and Richard Yeo, *Telling lives in science: essays on scientific biography* (Cambridge: 1996).

in the eighteenth century: the science of the system of the earth and its products.'[2] Aside from the works of Oldroyd, Torrens and Laudan,[3] this assessment still rings true today. In his earlier work, and then books that he later edited with Teich,[4] Porter demonstrated that conceptions of the natural world and the human body must be considered in relation to the differing social, intellectual and religious issues that so often existed between national contexts. For my study, the national context was Scotland; however, in light of the source material of my thesis, I needed to specifically concentrate on Edinburgh. To do this, I drew from Jardine's *The scenes of enquiry* in which he argues that in order to understand the questions considered to be 'real' in an intellectual community, a historian must learn to appreciate the 'considerations that would be taken in that community to be relevant to their resolution.'[5] In other words, the ideas espoused by a given natural philosopher must be considered in relation to the epistemological framework of the intellectual community that served to originate, validate and encourage his scientific enquiry. Jardine calls this community a 'local reality'. In the case of this thesis, John Walker is the natural philosopher and the Medical School is the local reality.

Several decades ago, Levere wrote: 'The history of any intellectual concept may be thought of as a more or less continuous thread, woven into and supported by the multiplicity of related strands that make up the back-cloth of society.'[6] Likewise, in order to identify the contextual 'threads' of Walker's social and intellectual background, Chapter 1 of this thesis presents the general contours of his biography. Starting with his youth in Canongate, the first section identifies the personalities that shaped his initial local reality and who contributed to his socio-political rise to influence. It then goes on to explain the format of his natural history course and to identify the types of students who attended the lectures. One common thread that runs throughout the chapter is the central role played by the chemistry practiced by the professors of the Medical School. Building on this theme, Chapter 2 focuses on Walker's training as a chemist. Although he was influenced by several different medical professors, his main teacher was William Cullen, the Professor of Chemistry.

[2] R. Porter, 'The terraqueous globe', in G. S. Rousseau and R. Porter, *The ferment of knowledge* (Cambridge: 1980), 285-324; quotation taken from page 285.
[3] D. R. Oldroyd, *Sciences of the earth* (Aldershot: 1998); *Thinking about the earth* (London: 1996). H. Torrens, *The practice of British geology, 1750-1850* (Aldershot: 2002). M. J. S. Rudwick, *Scenes from deep time* (Chicago: 1992). R. Laudan, *From mineralogy to geology* (London: 1987).
[4] R. Porter, *The making of geology: Earth science in Britain 1660-1815* (Cambridge: 1977); R. Porter and M. Teich. (eds), *The enlightenment in national context* (Cambridge, 1981).
[5] N. Jardine,. *The scenes of inquiry: on the reality of questions in the sciences* (Oxford: 2000), 56.
[6] T. H. Levere, *Affinity and matter: elements of chemical philosophy 1800-1865* (Oxford: 1971), 1.

The chapter goes on to explain that the main form of chemistry employed by Cullen and his colleagues was 'principle' based. It followed a highly empirical methodology and was used to perform experiments on both organic and inorganic material. Once Walker learned this form of chemistry, he put it to use during the 1750s in an article for the *Philosophical Transactions of the Royal Society*. The last sections of the chapter use this article to demonstrate that his knowledge of chemistry was sound and in line with the experimental pharmacology being conducted by Cullen and other professors in the Medical School.

During the mid eighteenth century, there were predominantly five 'principles' used in the chemistry employed by Scottish physicians: Salts, Earths, Metals, Fire and Water. Most often, the solutions and mixtures made from these principles were derived from minerals. This created an overlap between chemistry and mineralogy and encouraged systems that used each principle as a classification category. Chapter 3 explores this situation by tracing Walker's early mineralogical career. It begins by showing how his chemical education also served as an introduction to mineralogy. Cullen was quite instrumental in this process. He encouraged Walker's interest in 'fossils' and took him along on Lothian expeditions. After University, Walker followed in the footsteps of his mentor and began to tour the Lowlands extensively. He kept a series of notebooks during this time and they reveal that his first mineral classification system was based upon the divisions of five-principle chemistry. The mineralogical specimens included in this arrangement were taken from personal observation, both from the stones that he saw *in situ* and from those that were in his rapidly growing collection. Because his collection would grow to be the largest in the country, the last part of the chapter addresses how he used travel, patronage and correspondence to collect 'Stones' and 'Minerals'.

By the 1770s Walker was a recognised natural history authority in Scotland. He was the chief scientific advisor to Lord Kames and Lord Bute, and was also frequently consulted by other members of the aristocracy and gentry. This led him to be appointed to the University of Edinburgh's Regius Chair of Natural History in 1779. Although he lectured on many areas, his favourite topic was 'fossils' and he taught his students a mineralogical system of his own design. Chapters 4 and 5 investigate this system in detail. Since virtually no secondary work has been done on early modern mineral systematics, Chapter 4 discusses the sources and vocabulary that shaped his thought. Because his mineralogy was founded on chemistry, a large percentage of his sources were also used by the professors of the Medical School, especially the works of three Swedish chemists: J. G. Wallerius, A. F. Cronstedt and T. O. Bergman. Even though Walker did transplant botanical words into his mineralogical system, the fact that he used 'menstrua' and 'fire' to analyse stones meant that the vast amount of his vocabulary came from chemistry. Since these words, terms and concepts were in turn used by the Medical School to describe the composition and internal processes of the human body, the chapter ends by suggesting that eighteenth-century medicine and mineralogy share the same linguistic history.

Building on the chemical foundations of his mineralogical training and vocabulary, Chapter 5 goes on to demonstrate that Walker primarily based his classification system upon artificial (chemical) characters and *not* the natural characters that were employed by Linnaeus. He did, however, use the Linnaean quintuple classification categories: class, order, genus, species and variety. His first full-fledged system (1782) contained eighteen classes, but by the mid 1790s he had enlarged it to nineteen. In order to understand the specific content of one of these systems, Chapter 5 uses a set of 1797 student notes to show that he divided 'fossils' into two basic categories: Stones and Minerals. The primary component of Stones was the principle of Earth, which consisted of five different categories: calcareous, argillaceous, magnesia, siliceous and terra ponderosa. Minerals were made up of combinations of Salts, Metals and Inflammables. In addition to delineating his 1797 system, the chapter also investigates the composition of his Saxa Stones because of their relevance to his conception of geology. It demonstrates that even though he thought the rocks too large to be arranged via the artificial methodology that governed most of his other classes, he held that their form was chemically explicable, which implicitly subjected them to his chemical epistemology.

Having spent the bulk of the thesis explaining his chemical conception of stones in relation to his local reality, Chapter 6 addresses Walker's understanding of geology—a subject that was first introduced by him to the Edinburgh curriculum in 1782. The first part of the chapter draws together several points mentioned throughout the thesis. More specifically it shows how the methods and epistemology of principle-based chemistry fit into the staunch empiricism that dominated natural philosophy in Edinburgh at the end of the Enlightenment. Such a context eschewed the conjectural premises that lay at the base of theoretical cosmologies of the time. This meant that most of Walker's contemporaries had no time for the hypothetical cosmogonies contained in the works of Buffon, or even Descartes. Instead, they felt that the scientifically responsible way to discuss the structure of the earth was via chemistry, the most empirically sustainable subject recognised by their local reality. Not only did this discipline allow them to enter into highly empirical discussions about the composition of the primary, secondary and tertiary strata, it also removed the need to discuss historical time—because to do so would be unscientific. It was chemistry, therefore, that laid the epistemological foundation for Walker's geology and Chapter 6 goes on to investigate the various implications of this situation.

In addition to using Walker's career to explore the nascent earth sciences in Enlightenment Edinburgh, this thesis also seeks to highlight two significant points. The first is the intimate connection shared between natural history and medicine. This relationship had been highlighted by D. E. Allen and Hal Cook, but on the whole receives far too little attention.[7] The most obvious representation of this relationship is the fact that Walker's professorial chair was part of the medical faculty. On a more subtle level, these two 'disciplines' shared the same desire to classify the natural world. While natural historians like Walker were seeking to arrange the kingdoms of nature, physicians like Cullen were trying to systematise diseases and drugs. In Edinburgh the connection was even stronger because of the rampant use of chemistry. Building on the work of Maehle, Porter, Cowen and Coley,[8] this thesis further illustrates how the practice of principle-based chemistry, in combination with its interest in classification, united Edinburgh's naturalists and physicians into a commonly shared empirical methodology that directly impacted the mineralogically dependant practices of mining, bleaching and pharmacology. Such a concentration on classification also expands upon Knight's comments on the Enlightenment's concern for 'ordering the world' and allows several of the chapters to compare the taxonomical scene in Edinburgh to those of other parts of Britain and Europe.[9]

The emphasis placed upon chemistry leads to a second, and fundamentally historiographical, issue that is emphasised in this thesis. As each chapter unfolds, it becomes quite clear that the chemical and mineralogical sources which most

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[7] D. E. Allen, *Naturalists and society* (Aldershot: 2001). 'Physicians and natural history', in *Cultures of Natural History*, N. Jardine, *et al* (eds), (Cambridge: 1996), 91-105.
[8] A.H. Maehle, *Drugs on Trial* (Amsterdam: 1999). R. Porter (ed), *The medical history of waters and spas* (London: 1990). D. L. Cowen, *Pharmacopoeias and related literature in Britain and America* (Aldershot: 2001). N. Coley, '"Cures without care": "chemical physicians" and mineral waters in seventeenth-century English medicine', *MH*, **23** (1979), 191-214; 'George Fordyce M.D., F.R.S. (1736-1802): Physician-chemist and eccentric', *NRTSL*, **55** (2001), 395-409; 'Chemistry, medicine, and the legitimization of English spas, 1740-1840' (Porter: 1990).

influenced Walker and his contemporaries are seldom treated by historians of science. Moreover, as the conclusion of this thesis will reiterate, there is a significant difference between the sources that were given credence by eighteenth-century chemists and those which are treated in most histories today. This point is not a new one and has been explicitly addressed by Beretta and Christie.[10] More implicitly, it has been treated by Crosland, Duncan, Donovan, Thackray, Bensaude-Vincent & Abbri, and Knight.[11] However, despite the work of these historians, the historiography of early modern chemistry, for the most part, still concentrates on a canon that was created by nineteenth-century authors. Thus, no matter what methodology is used, the sources most often remain the same. This thesis therefore challenges the conception of a timeless scientific 'classic', or even an unchangeable 'canon', and takes forth Knight's observation that, 'The idea that there are classics of science in the same way there are classics of literature, works which the world should deeply note and long remember, is an odd one.'[12]

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[9] D. M. Knight, *Ordering the world* (London: 1981). More specifically, see Chapter 6: 'To the taxonomist, the problem is to determine the natural groups into which things fall, and then to devise some simple key so that anybody else can, without spending the same time in profound study, put them into the right category'.

[10] M. Beretta, *The Enlightenment of Matter: The definition of chemistry from Agricola to Lavoisier* (Canton: 1993); 'The historiography of chemistry in the eighteenth century: a preliminary survey and bibliography', *Ambix*, **39** (1992), 1-10. J. R. R. Christie, 'Historiography of chemistry in the eighteenth century: Hermann Boerhaave and William Cullen', *Ambix*, **41** (1994), 4-19.

[11] M. Crosland, *Historical studies in the language of chemistry* (London: 1962). A. Duncan, *Laws and order in eighteenth-century chemistry* (Oxford: 1996). A. L. Donovan, *Philosophical chemistry in the Scottish Enlightenment: The doctrines and discoveries of William Cullen and Joseph Black* (Edinburgh: 1975). A. Thackray, *Atoms and Powers* (Cambridge: Mass, 1970). B. Bensaude-Vincent, and F. Abbri (eds). *Lavoisier in European context: Negotiating a new language for chemistry* (Canton: 1995). D. M. Knight, *The transcendental part of chemistry* (Folkestone: 1974); *Ideas in chemistry: A history of the science* (London: 1995).

[12] D. M Knight, 'Background and Foreground: Getting things into context', *BJHS*, **20** (1987), 3-12; quotation from page 5. This point is also illustrated by the texts that he discusses in *Natural science books in English 1600-1900* (London: 1972). For more on modern concept of a 'classic', see F. Kermode's *The classic* (London: Faber & Faber, 1975). For the concept of 'canon' in the history of science (primarily nineteenth-century), see A. Fyfe, 'Publishing and the classics: Paley's *Natural theology* and the nineteenth-century scientific canon', *SHPS*, **33** (2002), 733-55. J. Topham, 'Scientific publishing and the reading of science in nineteenth-century Britain: A historiographical survey and guide to the sources', *SHPS*, **31** (2000) 559-612.

Rev. Dr. John Walker (1731-1803)
William Jardine, *Natural History*... (Edinburgh, 1842).

Pictured against the backdrop of Edinburgh with his two favourite pastimes: rocks and plants.

Chapter 1

Biographical Overview

Introduction

Rev. Prof. John Walker was in many ways quite an extraordinary character. He started out as the son of a schoolmaster, went on to become a minister in the Established Church of Scotland and ended his life as the Regius Chair of Natural History at the University of Edinburgh. This final post was under the financial jurisdiction of Parliament and King George III and is the quintessential symbol of the balance between science and patronage that Walker worked so hard to foster throughout his entire career. Yet, even though his tenacity and determination will be the focus of this chapter, it must be stated that he is just one character in the larger story of the scientific professionalisation that was occurring at the end of the eighteenth century in Edinburgh. Close examination of the careers of his contemporaries would reveal that his rise to influence was not atypical and that he should be seen more as a case study that represents the upwardly mobile dreams and expectations of many naturalists in Enlightenment Scotland. The connections and scientific exploits that catapulted him into the Natural History Chair were numerous. To distinguish himself above others, he dipped his cup into just about every area of natural history. Over the course of his career he wrote papers, articles and lectures on areas that would now be included under the disciplines of chemistry, mineralogy, botany, zoology, hydrology, meteorology, geology, geography, anthropology and civil history.

Considering Walker's many different interests, the following biography of his life is rather modest. It only seeks to trace his scientific career as it related to the spread of his ideas and his thoughts on the earth's structure. The first section begins by highlighting the fact that Walker spent the first half of his career as a parson naturalist. Finances were a perennial worry and he spent a good deal of his time trying to locate patrons who could help him find a permanent academic post that would allow him to pursue natural history. Although he would find many such patrons, the two most helpful turned out to be Henry Home, Lord Kames, and William Cullen, Professor of Chemistry at the University of Edinburgh (Plates 1.I and 1.II). From the 1750s to the 1770s, his personal endeavours in natural history and the contacts that he made via these two patrons allowed him to form a scientific network that strengthened his reputation as an authority on a wide variety of topics—the most notable being (chemical) mineralogy and georgics. These connections eventually allowed him to be appointed to the Chair of Natural History in 1779.

When he originally took up the Chair, he had intended to write a comprehensive natural history of the British Isles. However, his salary was restrictive and he had to spend a good deal of his time trying to supplement his income. This forced him to continually court his patrons and the town council. Despite the time consumed by these efforts, he worked hard to create a culture of natural history in Edinburgh. He did this by co-organising several societies, two of which were the Student Natural History Society and the Royal Society of Edinburgh. He also spent a good deal of time improving the collections of the Natural History Museum and creating entertaining lectures that inspired many of his students to go on to careers in science. Because his course was so popular, the second section of this chapter details how it was structured and then goes on to highlight a few of his students that would eventually go on to make a notable impact in the fields of science, medicine, politics and industry. One of the sub-themes of this discussion will be the central role played by chemistry, both in Walker's lectures and in the Edinburgh community. The conclusion will reiterate this point and set the stage for Chapter 2's treatment of Walker's early chemical education.

I. Scientific Biography

Parson Naturalist

Throughout his entire life, Walker's career as a naturalist was supported by the church, state and the aristocracy. The contacts afforded by this situation allowed him to be an influential naturalist in both Scotland and abroad. Although this chapter mainly traces his involvement with subjects relevant to the nascent earth sciences, he lectured and wrote on just about every area of natural history. He was born in Canongate (a suburb of Edinburgh) 1731 and died in 1803.[1] His father, John Walker Sr., was a schoolmaster and a Session Clerk of Canongate. Even though it is known that his father taught him Latin and Greek at an early age, his early years

[1] See the John Walker entries in the *DNB*, *DSB*, and *NewDNB*. The latter was updated by Charlie Withes and he was gracious enough to send me a photocopy of the file that he used to make his additions. Alexander Grant gives a succinct summary of Walker's time as professor in *The story of the University of Edinburgh* (London: 1884), 432-433 and Hew Scott summarises his church career in *Fasti ecclesiæ scoticanæ* (Edinburgh: 1866), 149.

Dr. William Cullen (1710-1790)
Based on William Cochrane painting. A. Doig, *et al.*, *William Cullen and the eighteenth century medical world* (Edinburgh: 1993), *frontispiece*.

Cullen was the University of Edinburgh's Professor of Chemistry during the 1750s, but went on to teach a wide variety of medical subjects, including *materia medica* and nosology. He met Walker in the early 1750s, proceeded to teach him chemistry and then took him on natural history tours in the Lothians.

LORD KAMES.

From an engraving after the portrait by Martin.

Henry Home, Lord Kames (1696-1782)
Woodhouselee, Alexander Fraser Tytler, Lord, *Memoirs of the life and writings of the Honourable Henry Home of Kames...* (Edinburgh: 1807), frontispiece.

Lord Kames was an Edinburgh Judge Advocate and was introduced to Walker by William Cullen in the mid 1750s. Kames supported Walker throughout his entire career as a naturalist and was one of the primary personalities involved in the politics that allowed him to be appointed Professor of Natural History at the University of Edinburgh in 1779.

remain enshrouded in anonymity.[2] During his adolescence he developed an interest in mineralogy that would last his entire life. He began to collect minerals as a child and continued this practice during his studies at the University of Edinburgh (1746-1749). While at university, even though his official course was divinity, he spent much of his spare time studying natural history and natural philosophy. Shortly after his official studies, he met the chemist and physician William Cullen whose scientific interests spanned the entire Kingdom of Nature. Walker began making tours by himself and with Cullen to the seaside and into the surrounding lowland environs of Edinburgh to obtain 'fossil' samples. These trips convinced him that the best way to study nature was *in situ*. As he would later state in his lectures: 'But neither here, nor in the closet, nor in the best furnished Museum, can any one ever expect to become a thorough naturalist. The objects of nature themselves must be sedulously examined in their native state. The Fields of the Mountains must be harvested, the woods and waters must be explored.'[3]

In the mid 1750s Walker joined the Edinburgh Philosophical Society, was ordained into the Church of Scotland and toured the Highlands with Cullen. He was licensed to preach during 1754 in Kirkudbrightshire and was then appointed minister of Glencorse in 1758 (the latter being located in the Pentland Hills, just seven miles south of Edinburgh). Even though he was given these two successive posts, he spent a great deal of time in Edinburgh. His visits to the capital allowed him to study with Cullen and then for him to be introduced to Henry Home, Lord Kames. It was via this relationship that Walker met Benjamin Franklin in 1759 and began to make important scientific and political connections. However, even though Walker was rubbing shoulders with Edinburgh's influential literati, he still did not have a clerical post that paid very much money. This led him to search for a larger church that was closer to Edinburgh. He settled his hopes on the moderately sized town of Moffat, Dumfrieshire, and he began to visit it on a frequent basis. In fact, he had even begun to visit the town before he was appointed to his post at Glencorse. The pulpit of the Moffat was under the patronage of Lord Hopetoun and Walker eventually managed to be appointed minister in 1762. His frequent forays to Moffat in the mid 1750s allowed him to roam around its moors and dales in search of minerals and plants. He was also keen on performing chemical experiments on several of its spas and this led

[2] His father taught at the Grammar School, Canongate. It was the rival to the more prestigious High School of Edinburgh. Andrew Dalzel, *History of the University of Edinburgh from its foundation* (Edinburgh: 1862), 103.
[3] T. Birch (transcriber), 'A General View of Its Literary History', *Notes and Lectures on Natural History Vol.. I* (1789) EUL Gen 50 ff. 40-41.

to his first academic article in 1757.[4] This publication addressed the composition of a mineral well just outside of the city and will be treated in detail in the next chapter.

During the 1760s, Walker sought to further his status as a natural historian by nominating Linnaeus to be a member of the Philosophical Society. He also strengthened his ties with Kames and forged links with land-improving Lords like those of the Hopetoun and Cathcart families.[5] The power of such patrons and his friendship with Cullen won him a commission to tour the Highlands in 1764. This tour was sponsored by the Board of Annexed Estates (BEA) and the General Assembly (GA) of the Established Church of Scotland. The BEA was controlled by local aristocrats and members of parliament and had been formed to administer the confiscated lands of Scottish nobles who supported the 1745 Jacobite Rebellion. It was therefore a political body and Walker probably would not have been appointed had it not been for his connections with Lord Kames. Additionally, since the British Parliament sat in Westminster, the GA was effectively the only publicly elected body in Scotland that had any influence over the political and social affairs. This made Walker an official representative of the Church and State.

In conjunction with his religious, political and social observations,[6] he spent a great deal of time taking soil samples, cataloguing minerals and performing experiments. These activities did not go unnoticed by the academic community and in 1765 they led to him being awarded an honorary M.D. from the University of Glasgow and a D.D. from the University of Edinburgh.[7] Now the Rev. Dr. John Walker, he made a bid to be the Professor of Church History at the University of St. Andrews in 1767. This sinecure was worth £160 and would have allowed Walker, in the words of Alexander Small, to 'have time to pursue his favourite study' of natural history.[8] However, this post never materialised. To further bolster his reputation and knowledge of natural history Walker took another trip to the inner Hebrides in 1771. Like the first, it was dually supported by the church and state.[9] He also took several more trips around Lowland Scotland, one of which he turned into a second

[4] John Walker, 'An Account of a New Medicinal Well, Lately Discovered in Moffat', *PT*, **50** (1758), 117-47.
[5] John, second Earl of Hopetoun (1704-1781) and his son James (1741-1816), who was styled Lord Hope in 1766. M. D. Eddy, 'James Hope Johnstone, third Earl of Hopetoun (1741-1816)', Colin Matthew, ed., *NewDNB*, (Oxford, forthcoming 2004).
[6] John Walker, 'Dr. John Walker's report to the assembly 1- 65, concerning the state of the highlands and islands', *Scots Magazine*, **28** (1766), 680-689. *Regular General Assembly of the Church of Scotland 1762-1765*. 'Walker on Catholicism', 589-628. NAS CH1/1/55.
[7] University of Edinburgh, *A catalogue of the graduates in the faculties of arts, divinity, and law of the University of Edinburgh, since its foundation* (Edinburgh: 1858), 243.
[8] Alexander Small to George Clerk. 1767. NAS 18/4103.
[9] John Walker, 'Dr. John Walker's report concerning the state of the Highlands and Islands, to the General Assembly 1772', *Scots Magazine*, **34** (1772), 288-293. *Regular General Assembly of the Church of Scotland 1772-1775*. '1772 Tour Report', 126-135. NAS CH1/1/63.

Philosophical Transactions article.[10] In all of his travels during the 1760s and 1770s, he kept detailed notes. This allowed him to fill his future natural history lectures and publications with interesting examples that he had personally observed.[11]

Walker's tours and connections to the landed class strengthened his reputation as a natural historian during the 1760s and 1770s. After much intrigue in which his political connections proved very helpful,[12] he was appointed to the University of Edinburgh's Regius Chair of Natural History in 1779—a post which was attached to the medical faculty. Although he was also made Keeper of the University Museum, the financial amenities of these two posts were low. As will be detailed below, professors made most of their money by collecting a fee from the students at the beginning of each lecture. Since Edinburgh had several unofficial natural history lecturers at the time (William Smellie for example), Walker needed time to build his reputation so that his course could compete in the educational 'market'. But since his base salary was low, he did not have enough money to move to Edinburgh. This forced him to remain in Moffat, thereby making it impossible for him to lecture. This situation continued for three years until other acts of political manoeuvring motivated Lord Lauderdale to appoint him to be the minister of Colinton in 1782.[13]

Colinton was closer to Edinburgh and this allowed Walker to commence with his natural history lectures. Now the Rev. Professor John Walker, he turned his past thirty years of experience into original contributions that shaped the fields of botany,[14] georgics (agriculture),[15] geology[16] and mineralogy. For all of his courses, Walker did a great deal of reading, as noted by Lord Woodhouselee:

> *It was his custom, for a great part of his life to indulge himself in nocturnal study; seldom feeling the resolution to quit his books and papers till four or five o'clock in the morning, and of course passing the best part of the day in bed; a practice which destroyed a good*

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[10] John Walker, 'An account of the irruption of Solway Moss', *PT*, **62** (1772), 123-127.

[11] Many of these essays were published late in his life or even posthumously. See 'An essay on peat, containing an account of its origin, of its chymical principles and general properties,' *PETHSS*, **2** (1803), 1-137; 'On the cattle and corn of the Highlands', *PETHSS*, **2** (1803), 164-203; 'Extracts on the natural, commercial, and economical history of the herring', *PETHSS*, **2** (1803), 270-304; 'On the natural history of the salmon', *PETHSS*, **2** (1803), 346-376. These essays were re-edited and added to other works that he had written during the entire course of his career in John Walker, *Essays on Natural History and Rural Economy*, Charles Stewart, ed., (Edinburgh, 1808) and *An economical history of the Hebrides and highlands of Scotland* (Edinburgh: 1808)

[12] This is treated in S. Shapin, 'Property, patronage, and the politics of science: The founding of the Royal Society of Edinburgh', *BJHS*, **7** (1974), 1-41. Shapin also treats other contextual matters relevant to Walker's appointment in: 'The audience for science in eighteenth century Edinburgh', *HS*, **12** (1974), 95-121.

[13] 8 July 1782. Presentation of the Earl of Lauderdale in favour of Doctor John Walker. EUL La.III.352/1 f. 54. This top-down appointment angered the parishioners of Colinton and half of them left the church. Such appointments handed down by patrons remained a continuing frustration in Scotland and eventually split the church in two during the nineteenth century.

[14] R. K. Greville, *Algæ Britanicæ*... (Edinburgh: 1830). G. Taylor, 'John Walker, D.D., F.R.S.E. 1731-1803. Notable Scottish Naturalist', *TBSE*, **28** (1959), 180-203.

[15] C. W. J. Withers, 'A Neglected Scottish Agriculturalist: the 'Georgical Lectures' and the Agricultural Writings of Rev. Dr. John Walker (1731-1803)', *AHR*, **33** (1985), 132-143.

[16] See Scott's 'Introduction', in John Walker, *Lectures on Geology*..., H. W. Scott (ed), (London: 1966). J. Ritchie, 'Natural History and the Emergence of Geology in the Scottish Universities', *TEGS*, **15** (1952), 297-316.

constitution, and the end was attended with the total loss of eyesight, for the last six or seven years of his life.[17]

Of all the topics that he studied and lectured on, mineralogy captivated a great deal of his attention during his last decade of lecturing. During 1780s, he published several pamphlet-style syllabi for his students that addressed mineralogical classification and by the 1790s he had devoted the largest part of his lectures to mineralogy. Indeed, the 1800 publication of a letter to Colonel Dirom, the Quarter Master General of Scotland (which addressed coal prospecting) demonstrates his public interest in subterranean matters.[18] Near the end of his career, he created more room for his mineralogy lectures by eliminating the subject of botany altogether. Additionally, in the early 1790s he expanded the lectures to include the marls and 'soils' that were of much interest to land owners. By the time Robert Jameson succeeded him as professor in 1803, the Chair of Natural History had become synonymous with mineralogy and geology.

Advisor and Correspondent

From the 1760s onward, Walker had intended to publish his own book of Scottish natural history based on the substantial amount of data he had collected on his expeditions. He had even gone to London in 1765 to obtain mineralogical specimens and to research plant samples in the British Museum.[19] Yet, to the dismay of academics and friends, this never happened. Both Cullen and Kames were especially frustrated on this point and continually harped on him for his failure to produce a definitive Scottish natural history textbook. The vast repository of his papers in Edinburgh University Library demonstrates that he indeed had the data to produce a first class work of natural history. The reasons why Walker never completed a published form of his lectures and personal notes are complex, but most probably stem from the fact that his attention was severely distracted during the late 1780s and early 1790s; the four most significant factors being his marriage to Jane Wallace Wauchope (1789), his term as Moderator of the General Assembly (1790), his unsuccessful bid for the Chair of Agriculture (1792) and the onset of blindness (sometime around 1795). Additionally it must also be remembered that Walker was in his late 40s when he was appointed professor and that he spent a great deal of his

[17] Thomas Murray, *The Parish of Colinton* (Edinburgh: 1863), 67. This quotation is taken from Woodhouselee's *Memoirs of the life and writings of the Honourable Henry Home of Kames* (Edinburgh: 1809).
[18] John Walker, *Letter to Colonel Dirom, Quarter Master General of Scotland, on the discovery of Coal* (Edinburgh: 1800).
[19] 29 October 1765, John Ellis to Linnaeus, in J. E. Smith, *A Selection of Correspondence of Linnaeus and Other Naturalists* (New York, 1978), 180. Originally published in 1821. 29 October 1765. William Walison to Richard Pultney. NLS Acc. 9533 No. 314.

time directly involved with Edinburgh's natural history community (which existed both inside and outside the walls of the university).

Because he never published a *magnum opus*, he has often been overlooked by historians. But his influence was indeed far from slight and was felt both at home and abroad. In Scotland, he was a key advisor on georgics and mineralogy to such nobles as Lords Hopetoun, Bute, Mure, Buchan, Daer and Cathcart.[20] Additionally, he corresponded with or visited the estates of many aristocrats and landed gentry, some of whom were Lord Northumberland, Sir John Pringle and Sir George Clerk-Maxwell. Walker was equally popular with several of Edinburgh's polymath Judge Advocates, particularly Lords Kames, Hailes, Gardenstone and Woodhouselee. Out of all these men, Walker was the closest to Kames. On the practical level, Walker gave Kames a great deal of advice on how to manage agricultural matters on his estates. Along with Thomas Reid, Walker also functioned as one of Kames' chief scientific advisors. Kames found Walker's advice quite useful when the Edinburgh debates on the classification of humans erupted during the early 1770s. This resulted in Kames consulting Walker when he wrote *Sketches of the history of man* (1774), his definitive position on the matter. Kames also sought Walker's advice when he composed *The Gentleman Farmer* (1776), which became a highly popular book on georgics. Additionally, Walker's ties with Lord Kames' family were so strong that he often wrote letters solely to Lady Kames. This relationship was indeed curious and several aspects of it are still unknown today because the Kames family will not allow the public to view some of the letters that they wrote to each other. Even so, Walker continued to correspond with Kames' son, George Home-Drummond, after Kames' death.

After Walker was made Professor of Natural History in 1779, his many areas of expertise and his personality allowed him to maintain fruitful relationships with professors in all four of the University of Edinburgh's faculties. By the 1780s, Cullen, Walker's former patron and mentor, had turned into a close friend. When Walker became busy with preparing his first set of natural history lectures in 1782, Cullen was the first one to chastise him for failing to keep in contact.[21] Walker also shared constructive professional relationships with other professors in the University, including Joseph Black, John Robison, James Gregory, Hugh Blair, John Hope and

[20] For more on Walker and Scotland's utilitarian agricultural improvement efforts in the eighteenth century, see C. W. J. Withers, 'On georgics and geology: James Hutton's 'elements of agriculture' and agricultural science in eighteenth-century Scotland', *AHR*, **42**, (1994), 38-48 and 'William Cullen's agricultural lectures and writings and the development of agricultural science in eighteenth century Scotland', *AHR.*, **37**, (1989), 144-156.
[21] 18 October 1782. William Cullen to Walker. EUL La.III.352/4 ff. 7-8.

Thomas Charles Hope. Walker's interaction with Black was a bit more intimate because of their connection to Cullen and because Black was the faculty co-sponsor of the student natural history society (to be detailed below). Additionally, it was Black to whom Walker turned when he became frustrated with several aspects of the new French chemical nomenclature.[22] Outside of the University, Walker also kept in contact with a great many Scottish naturalists, including John Anderson, Professor of Natural History in the University of Glasgow. These connections, combined with the fact that he was a popular lecturer, contributed to the spread of his ideas amongst the future British physicians, politicians, farmers, ministers and lawyers that he taught.

Walker's name was also known on account of his vast foreign correspondence. He began to establish this network in the early 1760s, especially in 1762 when he wrote his first letter to Linnaeus. By 1764, his reputation was known by Thomas Pennant who refers to him in a letter to William Cullen[23] and by John Ellis who mentions his name as a matter of course in a letter to Linnaeus in 1763.[24] Over the course of his career, he corresponded with a plethora of naturalists, some of whom included Sir Joseph Banks, Anne Blackburne, Carl Peter Thunberg, F. W. P Fabricius, Dr. Richard Pultney, Dr. Maxwell Garthshore and Dr. William Wright.[25] He also was in contact with friends and former students who had been sent to posts in India, Europe, the West Indies and North America. In his letters, he discussed classification, offered advice on the cultivation and preservation of samples and sometimes requested certain types of specimens. For instance in 1784, he sent Robert Liston, the British Ambassador to Madrid, a 'list of natural productions' that he wanted the diplomat to find in Spain.[26] In addition to such contacts, his scientific correspondence broadened when he was appointed Keeper of Edinburgh's Natural History Museum in 1779.[27] His network also increased dramatically when he became Secretary of the Physical Section of the newly formed Royal Society of Edinburgh (1783) and when he founded the Agricultural Society of Edinburgh (1790).[28] Additionally his term as Moderator of the Church of Scotland led him to correspond with the professors of divinity at the universities of Glasgow (Robert

[22] 1798. Walker to Joseph Black. EUL Gen.874/IV/51-52

[23] 21 April 1764, Thomas Pennant to William Cullen. 'I take the liberty of recommending to Mr. Walker a thorough Attention to the Zoology of the Western Isles…' EUL La.III.352/1 ff. 9-10.

[24] 29 October 1765. John Ellis to Linnaeus. J. E. Smith, *A selection of the correspondence of Linnaeus and other naturalists* (London/New York: 1821/1978), 180.

[25] See the list of Walker's correspondence in Appendix V.

[26] 24 January 1784, Walker to Robert Liston, NLS MS 5540 f.34 and EUL SC MS La.III.352/3. Walker was also in contact with Dr. John Rogerson, physician to the Russian court in St. Petersburg and Lord Cathcart, British Ambassador to Russia.

[27] C. W. J. Withers has treated aspects of this network in '"Both useful and ornamental" – John Walker's keepership of Edinburgh University's Natural History Museum, 1770-1803"', *JHC*, **5** (1993), 65-77.

[28] C. P. Finlayson, 'Records of Medical and scientific societies preserved in the university library, Edinburgh', *The bibliotheck*, **1** (1958), 14-19.

Finlay) and Aberdeen (Alexander Gerard). The letters to Finlay and Gerard are particularly interesting because they touch upon the need for clerics to be educated in scientific subjects.[29] Via his entire network, Walker discussed a variety of scientific subjects and received a wide range of specimens ranging from Siberian ores to West Floridian snake skins.

Natural History Mentor

Because of its links to national improvement and industry, natural history was taken quite seriously in eighteenth-century Edinburgh. As Emerson has shown,[30] Edinburgh's premier intellectual body at the time was the Philosophical Society. It often discussed natural history and topics closely related to it. In fact, Walker had originally attracted the attention of Cullen and Lord Kames with a marl collection that he gave to the Society in 1753/4. The popularity of natural history was instrumental in the founding of the Royal Physical Society in 1771 and the Royal Society of Edinburgh in 1783. Walker was directly involved with establishing the latter and, as mentioned above, was appointed secretary of the Physical Section. All of these societies were primarily interested in presenting and debating papers on new and exciting subjects. This means that Walker's course was probably the easiest way to obtain a solid introduction to the many topics included under the auspices of natural history. This would explain why he had such a wide variety of students.

One of the direct results of his lectures was the creation of a student natural history society in 1782. Founded as the *Societas Naturae Studiosorum [Edinburgensis]*, or the Natural History Society of Edinburgh, historians have sometimes confused it with the Royal Physical Society of Edinburgh.[31] Key to the birth of the Natural History Society was James Edward Smith (who would later go on to found the Linnean Society of London). In a letter written to his father in 1782, Smith summarised Walker's enthusiasm for the society: 'Dr. Walker the new professor, who is most amiable, worthy and ingenious man, no sooner heard of it than he offered us his museum to meet in, with the use of his books and specimens; and he begged to be admitted an ordinary member, which he accordingly was.'

[29] 30 April 1792. Robert Finlay to Walker, EUL La.III.352/1, ff. 130-131. 3 May 1792. John Anderson to Walker, EUL La.III.352/1, ff. 132-134. 12 May 1792. Alexander Gerard to Walker, EUL La.III.352/1, ff. 135-136. 12 May 1792. Archibald Davidson to Walker, EUL La.III.352/1, ff. 137-138.

[30] R. L. Emerson, 'The Philosophical Society of Edinburgh 1737-1747', *BJHS*, **12** (1979), 154-191; 'The Philosophical Society of Edinburgh 1748-1768', *BJHS*, **14** (1981), 133-176; 'The Philosophical Society of Edinburgh 1768-1783', *BJHS*, **18** (1985), 255-303.

[31] D. E. Allen, 'The natural history society in Britain through the years', *ANH*, **14** (1987), 243-45; 256.

Smith goes on to write that, 'We have had two public meetings: at the first Dr. Walker was president, and at the last I had that honour.'[32] As Allen has noted, the Natural History Society produced several naturalists who played significant roles in nineteenth-century botany.[33] Additionally, Withers has shown that the society had members from Britain, Europe, the Caribbean, North America and South America.[34] Meeting several times per term, its members would read and discuss essays on a wide variety of topics. After each meeting, the essays were copied into a book of proceedings by the secretary. After two decades, this process produced 15 volumes of notes. Sometime during the nineteenth century, the proceedings were leather bound. By the early twentieth century they had been placed in the Edinburgh Central Library. Today they are housed in the University of Edinburgh's Special Collections Department under the title *Papers of the natural history society 1782-1800*. Of the 15 original volumes, 12 are extant.[35]

A browse through the papers demonstrates that about half of their authors attended Walker's course. As the society's goals were directly related to his own work, he supported its efforts by placing some of the Natural History Museum's collection at their disposal. To aid in the efforts of his students, Walker also chaired sessions and offered several papers of his own. His first paper addressed zoology: 'A description of a whale case ashore at Burntisland in Fife' (1782); the second addressed botany: 'An account of the fructification of the clavaria' (1783); and the third addressed geology and mineralogy: 'On subterranean heat' (1789).[36] Interestingly, the topic of the next meeting that followed Walker's paper on the whale was a letter about trees and shrubs sent by Lord Buchan, Walker's student and patron.[37] The society's papers also reflect the Edinburgh community's strong interest in chemistry. For this reason, it should not come as a surprise that another of the society's patrons was Joseph Black. As Smith noted in 1782: 'Our Natural History Society goes on gloriously. Dr. Black, professor of chemistry, is become an honorary member, and spoke there last Friday. Dr. Walker is there constantly, and

[32] 15 April 1782. Mr. James Smith to his Father. J. E. Smith,. *Memoir and Correspondence of the late Sir James Edward Smith, M.D.*, Lady Smith (ed), (London: 1832), 44-47.
[33] D. E. Allen, 'James Edward Smith and the Natural History Society of Edinburgh', *JSBNH*, **8** (1978), 483-93.
[34] C. W. J. Withers, 'Spatial history: Re-thinking the idea of place: Geography, natural history and the eighteenth-century enlightenment: putting the world into place', *HW*, **30** (1995), 136-163; see his graphs on page 156 and 157.
[35] *Papers of the natural history society 1782-1800* (hereafter *PNHS*), Vols. 1 - 15, EUL Da 67. Volumes V, XI and XIV are missing. As the note placed in Vol. I indicates, these bound manuscripts were housed in the Central Library of Edinburgh until the beginning of the twentieth century.
[36] John Walker, 'An Account of the Fructification of the Clavaria', EUL Da 67, *PNHS* Vol. II, ff. 60-65; 'A Description of a Whale cast ashore at Burntisland in Fife on the 10th of June 1761', EUL Da 67, *PHNS* Vol. V, ff. 89-99; 'On Subterranean Heat, EUL Da 67, *PHNS* Vol. VIII, ff. 175-186.
[37] David Steuart Erskine (Lord Buchan), "Communication by the Earl of Buchan", EUL Da 67, *PHNS* Vol. I, f.99-103

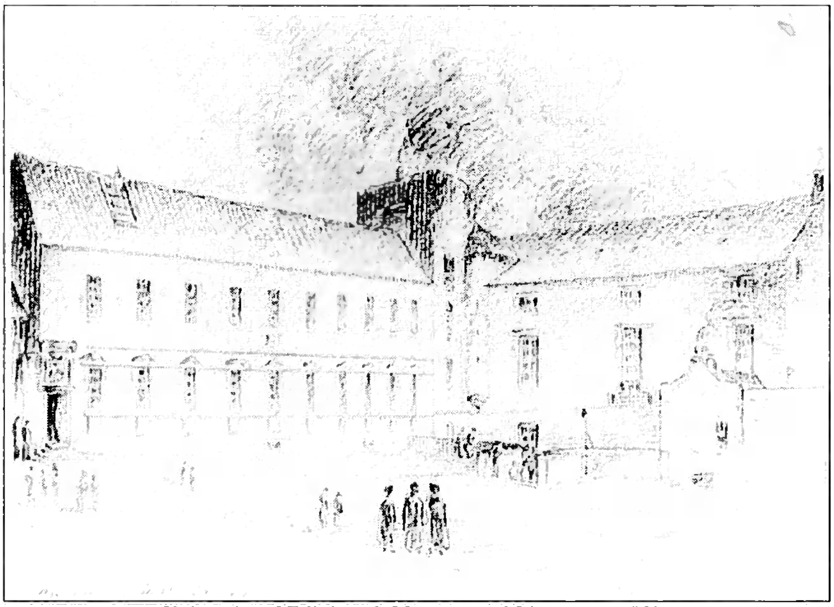
generally speaks.'[38] Half of the papers employ some form of chemistry to analyze the mineral, vegetable or animal kingdoms. This continued use of chemistry is significant when one considers that a student chemistry society was founded in 1785. Based on the former's membership list,[39] it can be seen that a few of Walker's students were a member of both societies (Thomas Beddoes and John Unthank for example).

II. The Natural History Course

Studying Nature

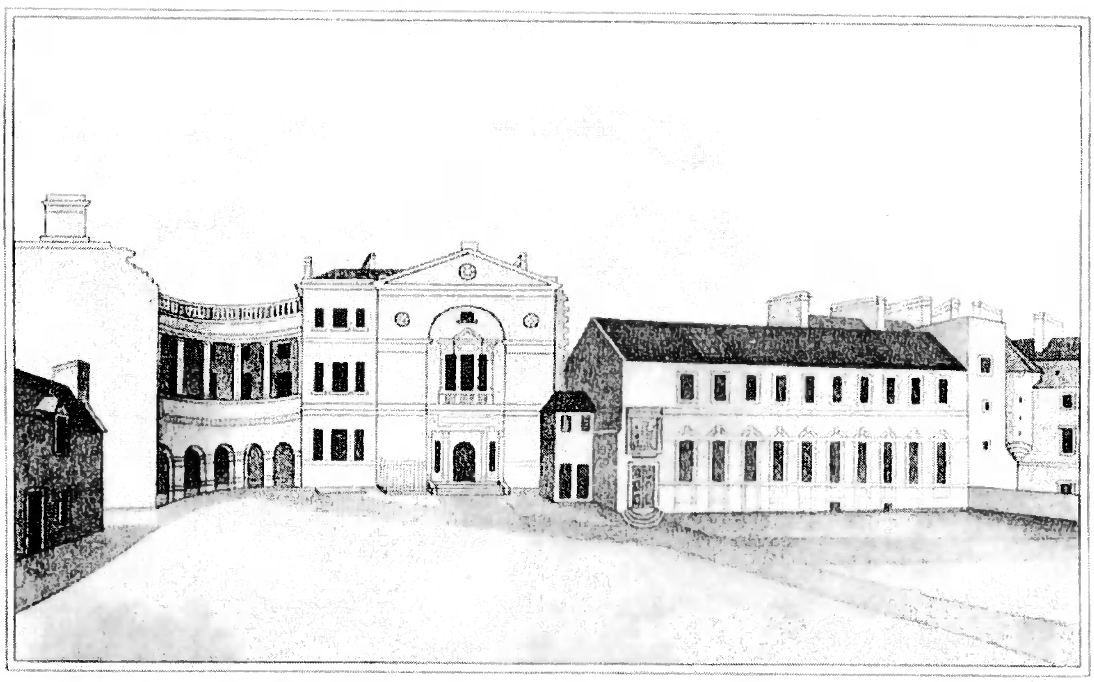
The above section demonstrated that Walker was a notable personality in the natural history culture of Enlightenment Edinburgh. Since his influence was particularly strong on account of his natural history course, this section will explore it in more detail. At the end of the eighteenth century the University of Edinburgh's Medical School was one of the leading scientific institutions of Europe. Natural history played a particularly strong role in its curriculum and in 1767 this led to a Regius Chair being established for the subject. As a financial amenity, the town council attached the keepership of its newly created Natural History Museum to the position (Plate 1.III). The first incumbent was Dr Robert Ramsay, who never gave a lecture. Ramsay died in 1778 and, after much political intrigue, Walker was appointed to take his place. Like many of the Medical School professors, Walker kept class lists. This was because the students paid their fees directly to him and not the University. Most of these lists still exist and are housed in the University of Edinburgh.[40] The standard fee was three guineas (£3-3-0), but Walker made exceptions for divinity students, sons of the University faculty or those who were experiencing financial difficulties. The reduced rate was usually two guineas (£2-2-0). In addition to noting methods of payment, Walker's lists sometimes record valuable information about the student's origin, degree and profession. Based on his individual class lists, the University of Edinburgh's Special Collections Department houses a master list of indexed cards bound together into four small volumes. These are entitled Index to the *Students in natural history class lists 1782-1800* (vols. I –

[38] 16 May 1782. Mr. James Edward Smith to his Mother. Smith (1832), 48.
[39] Published in J. Kendall, 'The First chemical society, the first chemical journal, and the chemical revolution', *PRSE*, **63A** (1952), 347; see also pages 346-358 and Kendall's, 'The first chemical society, the chemical journal, and the chemical revolution (Part II)', *PRSE*, **63A** (1952), 385-400.
[40] These lists are in manuscript form and are housed in the EUL Dc.1.18 collection. John Hope's class lists have also been treated by C. E. Nelson, 'Scottish connections in Irish botany and horticulture, *The Scottish naturalist*, (1987), 3-31.



University of Edinburgh Museum and Library (c. 1820)
James Skene (1775-1864)
Edinburgh City Library

In addition to being Professor of Natural History (1779-1803), Walker was also appointed to be the Keeper of the University's Natural History collections. The museum inhabited the first floor of the left wing of the building above. The same building from a different angle is pictured below.



University of Edinburgh Lecture Halls (c. 1810)
T. G. Stevenson, *Edinburgh in the Olden Time* (Edinburgh: 1880).

IV) and bear no shelf mark.[41] This master list contains more than 650 names and has been anonymously annotated over the past 50 years by the library's staff and by scholars studying the collection. These lists contain many interesting entries, several of which will be detailed shortly.

Walker's lectures began in November and ended in May. Based on the number of lectures that he gave per year, he must have given at least two per week, with the exception of a brief Christmas holiday at the end of December. He did all of the lecturing himself, save for the last few years of his life when he started to go blind. The lectures were divided into two sections. The first half addressed what Walker called 'Hippocratean' topics. The three subdivisions of this area were hydrology, meteorology and geology. The second half of the lectures addressed the 'Kingdom of Nature', that is, mineralogy, botany and zoology.[42] The sources cited in Walker's lectures were mainly books, articles and personal observations. The books consisted of works in English, Latin and French and the articles were usually taken from the *Philosophical Transactions of the Royal Society of London.* Additionally, he sometimes cites personal conversations with professors from the medical faculty. At the beginning of his teaching career (*c.* 1786), he was quick to mention to the town council that the University library did not house several of the texts needed by the students taking his course.[43] Even though there were other well-stocked collections in the city, it seems that he was his own lending library during the 1780s. Cornelius Elliot made a detailed list of these books after Walker died and printed it under the title *A catalogue of books in natural history with a few others that belonged to the late Rev. Dr. John Walker* (1804).[44] The books were sold on the 14th of May, 1804, with the proceeds going to Walker's widow and to the natural history museum.

Walker's natural history lectures were particularly successful because of two teaching aids. The first was the use of specimens from the Natural History Museum. Walker showed his students samples of minerals and might have even performed some chemical experiments upon these specimens. This brand of scientific

[41] C. W. J. Withers also treats Walker's class lists in 'The Rev. Dr. John Walker & the practice of Natural History, *ANH,* **18** (1991), 201-220. However, it must be stated that some of Withers' graphs at the end of the article offer different student numbers than what appear on *Student in natural history class lists 1782-1800* (vols. I – IV). For a comprehensive list of Walker's known students, see the one that I have compiled in Appendix V. It contains an alphabetised table made out of Walker's class lists. It primarily is based on *Students in natural history class lists* (EUL Reading Room), with many of the entries being double-checked against the manuscript lists in Edinburgh's Walker collection.

[42] J. Walker, *Lectures on geology...*, H. W. Scott (ed), (London: 1966).

[43] This point is made in a letter that Walker wrote to the city council in the mid 1780s. Since the purpose of the letter is to ask that the council award him more money, the rhetorical context of Walker's comments about the library needs to be taken into account. See John Walker to Edinburgh Town Council [c.1786], EUL La.III 352/2 ff. 7-8. Walker was raising this point to the town council because they ran the University.

[44] C. Elliot, *A Catalogue of the books in natural history with a few others, which belonged to the late Rev. Dr. Walker, Professor of Natural History in the University of Edinburgh* (Edinburgh: 1804).

showmanship was practiced by several of Walker's teachers, William Cullen especially,[45] and it continued to take place in the classes of his contemporaries.[46] A second teaching aid was a printed syllabus. This consisted of the heads of the lecture. The student could follow along and take notes in the margins or in a separate notebook. These syllabi were printed by local publishers and could be bought by students. The best surviving example is *Institutes of natural history* (1792).[47] This listed the heads of his Hippocratean and Kingdom and of Nature lectures and was popular enough in Britain to be included in Joseph Banks' *Catalogus bibliothecæ historico-naturalis* in 1798.[48] He also produced a similar syllabus for his mineralogy lectures. Entitled *Schediasma fossilium* (1781) it consisted of genus and class headings. During the late 1780s, he slightly altered *Schediasma's* mineralogical classification and added spaces between the heads so that more notes could be taken on the actual sheet itself. By composing these syllabi, Walker made it easier for his students to follow him during the lecture. This allowed many of them to produce notes that could be stenographed and then bound, thereby providing the student with a complete set of natural history notes.

University Students and Aristocrats

The students who took the natural history course came from all four of the University's faculties (medicine, law, divinity and arts). This was a common practice because the University's matriculation policy allowed students to attend subjects that were not required for their degree. Since the natural history chair was part of the Medical School, about half of the students were studying for a medical doctorate.[49] Several of his students went on to become known in medicine and natural history. Robert Waring Darwin, son of Erasmus Darwin and father to Charles Darwin, became a successful physician. He attributed this success to his training at Edinburgh and consequently sent his son, Charles, to study there. James Edward Smith founded the Linnean Society of London. Thomas Charles Hope, son of John Hope, Edinburgh's Professor of Botany, was appointed Professor of

[45] The content and pedagogical intentions of the Cullen's lectures are treated in A. Doig, J. P. S. Ferguson, I. A. Milne and R. Passmore, *William Cullen and the eighteenth century medical world* (Edinburgh: 1993).
[46] J. B. Morrell, 'The University of Edinburgh in the late eighteenth century: Its scientific eminence and academic structure', *Isis*, **62** (1971), 158-171.
[47] J. Walker, *Institutes of natural history; Containing the heads of lectures in natural history; Delivered by Dr. John Walker, in the University of Edinburgh* (Edinburgh: 1792).
[48] Jona Dryander, *Catalogus bibliothecæ historico-naturalis* (London: 1978), 187.
[49] The Medical School's curriculum and organisational structure of the University of Edinburgh at this time is treated in L. Rosner, *Medical education in the age of improvement Edinburgh: Students and apprentices 1760-1826* (Edinburgh: 1991); J. Geyer-Kordesch 'Comparative difficulties: Scottish medical education in the European context (c.1690-1830)' in V. Nutton and R. Porter (eds), *The history of medical education in Britain* (Amsterdam: 1995), 94-115; T. N. Bonner, *Becoming a physician – Medical education in Britain, France, Germany, and the United States* 1750-1945 (Oxford: 1995).

Chemistry at the University of Edinburgh in 1787. Thomas Beddoes became a well-known physician and was instrumental in mentoring the young Humphry Davy.[50] He wrote, edited and translated many books that influenced the practice of medicine and natural history. Some of his translations included Spallanzani's *Dissertations relative to the natural history of animals and vegetables* (1784), Bergman's *A Dissertation on elective attractions* (1785) and Scheele's *Chemical essays* (1786). After his time in Edinburgh, Beddoes maintained a favourable relationship with Walker. So much so that he asked his former teacher to give a mineralogy lecture to some friends who were visiting from London.[51]

Walker taught many students who would go on to influence the larger practice of natural history. One of the most notable was Robert Jameson, who succeeded Walker as Professor of Natural History in 1803. He was a leading Wernerian, established the Wernerian Society and published several influential books on mineralogy and geology, some of these being *System of mineralogy* (1804-1808), *Elements of geognosy* (1808), *Treatise on the external, chemical and physical features of minerals* (1816) and *Manual of Mineralogy* (1821).[52] Walker's legacy was also carried on outside of Edinburgh. Mungo Park explored the Niger River and was made famous by his *Travels in the interior districts of Africa* (1799). This work went through numerous editions and was translated into German and French. Robert Brown travelled to Australia with Sir Joseph Banks and first observed Brownian Motion (the movement of pollen grains during fertilisation).[53] The botanical notes and specimens from his Irish tours contributed to the second edition of the *Cybele hibernica* (1898) and are now housed in the Natural History Museum of London.[54] Another medical student, Samuel Latham Mitchell, became Professor of Chemistry at Columbia University (New York) and then served as a U.S. senator (1804-1809). Similarly, Francis Barker was appointed Professor of Chemistry at Trinity College Dublin in 1809. He published *Observations, chemical and practical, on the Dublin*

[50] For Beddoes, see R. Porter *Doctor of society: Thomas Beddoes and the sick trade in late-Enlightenment England* (London: 1992) and D. A. Stansfield, *Thomas Beddoes M.D. 1760-1808* (Dordrecht: 1984). For Davy, see D. M. Knight, *Humphry Davy: science & power* (Cambridge: 1998).

[51] Saturday Morning (undated). Thomas Beddoes to Walker. EUL La.III.352/4 ff. 30-31.

[52] L. Jameson, 'Biographical memoir of the late Professor Jameson in Edinburgh', *New Philosophical Journal*, 7 (1854), 1-49. Walker's relationship with Jameson (including the fate of Walker's mineralogical collection) is treated throughout the article. Also see J. Ritchie, 'A double centenary—two notable naturalists, Robert Jameson and Edward Forbes', *PRSE Section B*, **66** (1955-57), 29-57.

[53] The motion of fluids in plants was an aspect of botany that Walker impressed upon several of his students. To this goal, he presented a paper 'On the Motion of Sap in Trees', to the Natural History Society in 1784. See *Papers of the Natural History Society*, EUL Special Collection Da 67 Nat His vol. III, ff. 1- 29. Brown took this a bit further and used a microscope to observe how pollen moved when it was placed in water. See Robert Brown, 'A brief account of microscopical observations made in the months of June, July and August, 1827, on the particles of contained in the pollen of plants; and on the general existence of active molecules in organic and inorganic bodies', in John J. Bennett (ed), *The miscellaneous botanical works of Robert Brown... Vol. I.* (London: 1866), 463-486.

[54] E. Charles Nelson, 'Scottish connections in Irish botany and horticulture, *The Scottish naturalist*, (1987), 3-31; D. J. Mabberly, *Jupiter botanicus: Robert Brown of the British Museum* (London: 1985).

pharmacopoeia of 1826 (1829) and conducted botanical research that was later used in Mackay's *Flora hibernica* (1836).[55]

Since natural theology and moral philosophy drew many examples from natural history, many students reading for divinity and arts degrees were enrolled in the course. The fact that natural philosophy was part of the arts faculty also drew the interest of scientifically inclined law and theology students who were not studying medicine. For instance, one of the best-preserved sets of lecture notes came from the law student [Sir] David Pollock.[56] For Presbyterian divinity students, the course's appeal was no doubt related to the fact that Walker was ordained in the Established Church of Scotland and that he held an honorary D.D. Perhaps this is why the course also attracted the 'missionary' Daniel Miller. In addition to the University students who were reading for official degrees, there were also those from the city or nearby community who attended the course out of personal interest. Several of the students came from the aristocracy or upper-class. Two of the most conspicuous names on the list are those of Lord Buchan and Lord Daer. During the late 1770s, both had played a key role in appointing Walker to the Chair of Natural History.[57] Additionally, Daer along with the Judge Advocate Lord Nairn, another of Walker's students, was intimately involved in the creation of the Natural History Museum that was under Walker's keepership.[58] Other names from the nobility or landed gentry include, Lord Brooke, Lord Ashburton and Sir James Hall of Dunglass. The latter was known for his friendship with James Hutton and for his *On the consolidation of the strata of the earth* (1825).[59]

Many of the above students came from families who owned vast tracts of property. One of the reasons that land owners attended Walker's course was because they wanted to improve the productivity of their land. His natural history lectures on mineralogy, botany and zoology touched upon several topics that were relevant to land improvement, especially mining, agriculture and animal husbandry.[60] He was especially keen to entice such students, so much so that he focused a large section of his mineralogy lectures on the composition of various types of soils. This led him to

[55] This is discussed in Nelson (1987).
[56] David Pollock (transcriber), *Epitome of Natural History* (1797) Vols. 1-10, EUL Gen. 703D-712D.
[57] Shapin (1974).
[58] See Lord Daer to Walker, 21 October 1791, EUL La.III.352/1 ff. 120-21. Daer and Nairn both appear on a list of principle patrons of the museum: EUL La.III.352/5 f. 1. Although he was not a frequent attendee, Daer was also a member of the Coffee House Philosophical Society that met in London from 1780 to 1787. See Levere and Turner (2002).
[59] See 'Account of a series of experiments shewing the effects of compression in modifying the action of heat' read in the Royal Society of Edinburgh, 3 June 1805 EUL S.B. .5364 Hal. and 'Experiments on whinstone and lava', read in the Royal Society of Edinburgh, 5 March and 18 June 1798, EUL SC 6408.
[60] The interaction between natural philosophy and land improvement was experienced in most western European countries. For France, see E. C. Spary, *Utopia's garden* (London: 2000), especially pages 82-84 and 117-132. For other parts of Europe, see T. Frängsmyr R. E. Rider, J. L. Heilbron (eds), *The quantifying spirit in the 18th century* (Berkeley: 1990).

start giving separate agricultural lectures in the 1790s and these confirmed his status as a locally recognised expert on georgics.[61] However, his interest in georgics began to wane in the late 1790s after he unsuccessfully tried to secure the Chair of Agriculture. Even so, during his tenure, his lectures were attended by the sons of several aristocrats: Lords Polkemmet, Cockburn, Dudley of Ward, Westhall and of Sir James Colquhoun, Sir Alexander Don of Newton, the Honourable Henry Erskine, Sir William Forbes, Sir Archibald Hope, Sir James Hunter-Blair and Sir Peter Warrender. He also taught the brother of Lord Blantyre and the four brothers of Sir Charles Douglas of Kilhead.

Professionals, Merchants and Others

Even though the majority of the students were officially enrolled for a degree, there were also several professionals. Walker's class lists included Writers to the Signet,[62] schoolmasters, soldiers, surgeons, apothecaries, preachers and ministers. Of the surgeons listed, a high percentage were in the navy (it should not be forgotten that Walker's tenure overlapped with the French Revolution and Britain's subsequent war with France). A few of the surgeons were also enrolled as medical students, which fits with the rising role of surgeons during this period. In regard to the clergy, it seems that Walker uses the term 'preacher' to connote ministers of non-established churches. This being the case, there are almost thirty of them. This can be compared to seven 'ministers' who are given the title of 'Rev.'. Included in this category are Rev. Dr. Andrew Hunter, Edinburgh's Professor of Divinity and Rev. John Playfair, Professor of Mathematics. Playfair was a strong supporter of the geological ideas laid out in James Hutton's *Theory of the Earth* (1795) and was eventually appointed to be Professor of Natural Philosophy (1805).

As with the landed classes, Walker's class lists contain the sons of professionals in and around Edinburgh. He took care to note that he taught the progeny of several well-known ministers (Rev. Dr. Thomas Davidson, for example), surgeons, medical doctors, military officers and university faculty members (professors Alexander Hamilton, John Hope and Dugald Stewart). Four of his students were also involved in the pharmaceutical trade: John Bartlet, Mr Dempster, John Scott and Thomas Kinnaird. Of these four, Bartlet and Dempster listed the title 'apothecary', which meant that they were most probably medically qualified, but

[61] C. W. J. Withers, 'A neglected Scottish agriculturalist: The 'georgical lectures' and agricultural writings of the Rev. Dr. John Walker (1731-1803)', *AHR*, 1985, 33: 132-143.
[62] 'Writers to the Signet' are 'law-agents who conduct cases before the Court of Session, and have the exclusive privilege of preparing crown writs, charters, precepts, etc.' *OED*.

only by apprenticeship. Scott called himself a 'Chymist' and Kinnaird was content with the title of 'Druggist'. Because of the pharmacological trade's close involvement with chemistry, these men would have been at home with Walker's frequent use of the subject—especially in the mineralogy lectures. Of these four, Kinnaird was the most involved in the University's natural history community, giving a paper in the second session of the student Natural History Society. In addition to this involvement, Cowen's work on pharmacology has shown that it is possible that some of Walker's other students (Andrew Duncan, Ralph Irving, Richard Pearson and John Thompson) helped produce different editions of the Edinburgh *Pharmacopoeia.*[63]

Another group of students can be vaguely labelled as 'merchants'. Four men give themselves this title: Daniel Ainslee, William Braidwood, George Cadell and James Gardner. Additionally, there is a printer, a fossilist and a painter. Amongst those involved in the book trade is the printer James Neill and a 'Mr. Creech' who was a 'Bookseller'. The latter is undoubtedly William Creech, with whom Walker corresponded during the 1790s.[64] Creech published several works on medicine, some of the more notable being Jon Moncrieff's *An inquiry into the medicinal qualities and effects of the aerated alkaline water* (1794) and Alexander Monro's *Observations on the structure and functions of the nervous system* (1783). He also published the 1791, 1797 and 1801 editions of *The Edinburgh New Dispensatory*, William Smellie's translation of Buffon's *Natural History* (1780) and Robert Kerr's standard English translation of Lavoisier's *Elements of chemistry* (1790). This link to the new French nomenclature is significant because of Walker's involvement with Cullen, Black and the Scottish chemical community. Such a connection with chemistry sheds light upon two names that would otherwise seem out of place in a list of university students: One is William Burrel and the other is George Walker. Burrell is listed as a 'fossilist'. Since Walker was responsible for acquiring new minerals for the Natural History Museum, his interest in their chemical composition would have influenced the requests he made from a supplier like Burrell. After Walker began to teach, he began to rely increasingly on such 'fossilists' (whom he also calls lapidaries). This fact can be seen in the list of his mineral sources that is contained in the initial pages of his *Systema fossilium* (*c*.1797).[65] Like a fossilist, a painter's livelihood would have also been related to fossils. With the help of

[63] D. L. Cowen, *Pharmacopoeias and related literature in Britain and America, 1618-1847* (Aldershot: 2001), 57-58; 89; 201.
[64] William Creech to Walker, 12 April 1791, EUL La.III.352/1 f. 115.
[65] John Walker, Systema fossilium, Bound MS, Glasgow University Library Special Collections Department (GUL) MS Gen 1061 (1795 Watermark).

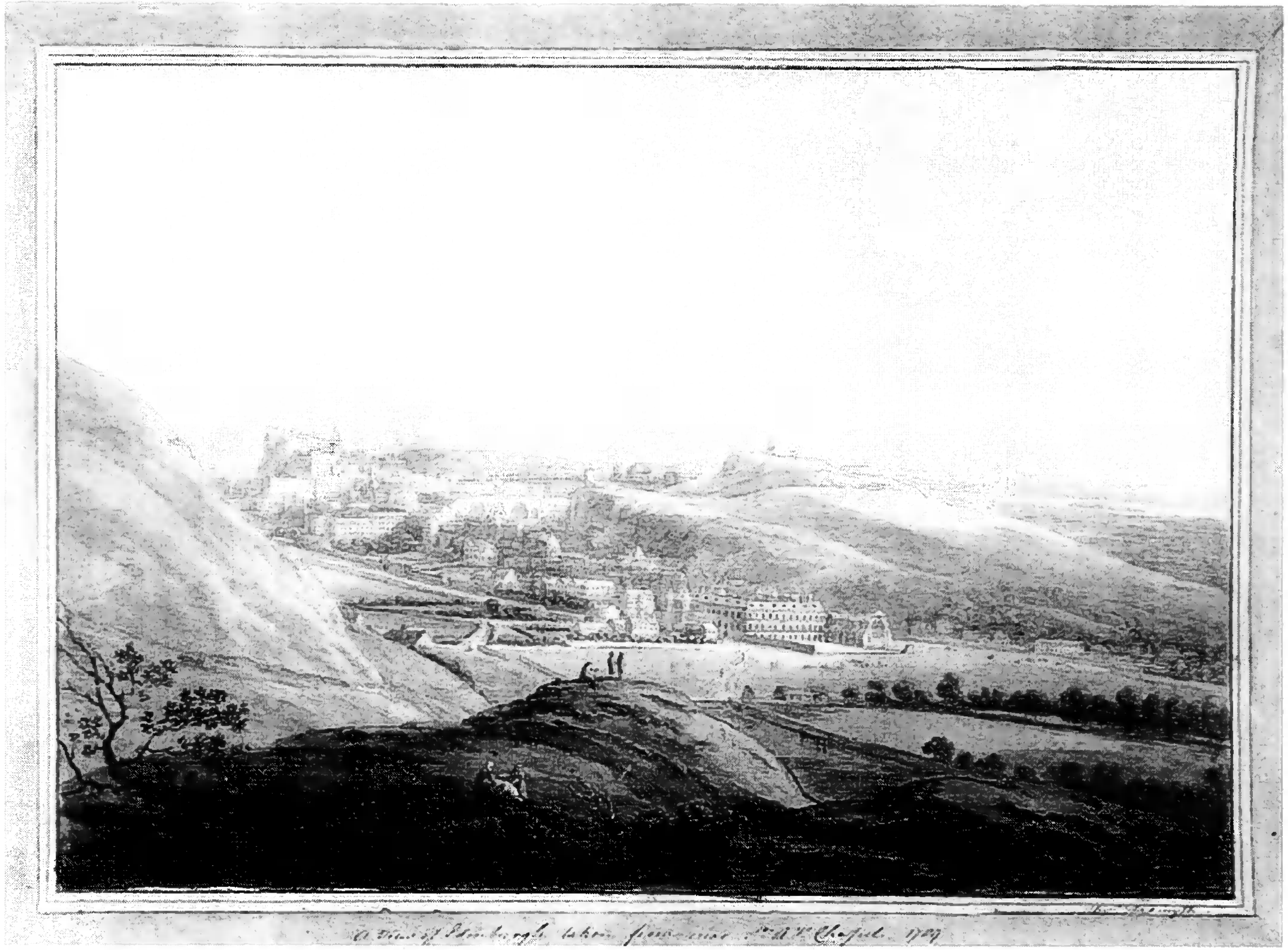
chemistry, several different types of minerals could be used to make paint pigments.[66] This might possibly be the reason that George Walker, who lists himself as a 'painter', enrolled himself in the natural history course. However, he might have also wanted to gain a more intimate knowledge of minerals for aesthetic reasons. As John Clerk of Eldin was showing at the exact same time, a knowledge of natural history was closely linked to understanding the rugged terrain of the Scottish landscape (Plate 1.IV).[67]

Conclusion

This chapter has traced the larger contours of John Walker's scientific biography. The first section demonstrated that he it was his dual connection with the church and landed patrons which sustained his career as a naturalist. Such a situation was common for the time and a close examination of Walker's correspondence would reveal that Scotland had a thriving community of parson naturalists. His connection to Lord Kames was politically and financially sustaining during the 1750s and 1760s—although William Cullen did work hard to introduce his student to other eminent naturalists and aristocrats in Scotland. Via these connections, Walker was able to obtain two appointments to explore the Hebrides and Highlands. Such activities allowed him to make even stronger contacts with the aristocracy and to create a large correspondence network. In this capacity, he kept in contact with well known figures like Linnaeus and Joseph Black, but also fostered relationships with a wide variety of naturalists that lived in Britain, Europe and abroad. All of these activities resulted in Walker being appointed to the Regius Chair of Natural History at the University of Edinburgh in 1779. In this capacity he mentored students not only through his courses, but also in helping them found various natural history societies. He was close friends with many professors and made valuable contributions to botany, georgics, zoology, mineralogy and geology.

The second section of this chapter treated Walker's natural history course. It began by addressing the format of the lectures, the way students paid for the lectures and the pedagogical tools that Walker used. The rest of the chapter detailed the

[66] This is and other chemical factors relevant to creating dyes and paints are treated in R. Fox and A. Nieto-Galan (eds), *Natural dyestuffs and industrial culture in Europe, 1750-1880* (Canton: Science History Publications, 1999) and G. E. and P. E. A. Pastrana (eds), *Between the natural and the artificial: Dyestuffs and medicines* (Turnhout: Brepols, 2000).
[67] G. Y. Craig, D. B McIntyre., and C. D Waterston. (eds), *James Hutton's theory of the earth. Reproductions of drawings, mostly by John Clerk of Eldin* (Edinburgh: 1978). Later aspects of this interaction are treated in M. Pointon, 'Geology and landscape painting in nineteenth-century England', L. J. Jordanova, R. S. Porter (eds), in *Images of the earth* (Chalfont St. Gilles: 1979), 84-116.



A view of Edinburgh taken from near St. Anthony's Chapter 1789
Alexander Nasmyth (1758-1840)
National Library of Scotland, Edinburgh

Chapter 1. Plate IV.

types of students that sat in Walker's lectures. Even though many of them would go on to be famous, the names of others were highlighted in relation to how they represented significant aspects of the natural history course's composition in general. Since Scotland's land owners were interested in improving their lands, there was a notable amount of aristocrats, gentlemen and sons of members of parliament who attended. However, the largest proportion was by far students who were reading for a medical doctorate. But the structure of the university allowed students to take any course that they wished and this allowed students from the law, divinity and arts faculties to attend Walker's lectures. A smaller percentage of students were clergymen (or their sons). The remaining number consisted of merchants, surgeons, apothecaries, druggists, fossilists, painters and book publishers.

A key point emphasised throughout this chapter was the central role played by chemistry in Enlightenment Edinburgh. Because of its immense influence in the Medical School, it had a profound impact upon the practice of natural history—a relationship that was further strengthened when the natural history post was attached to the medical faculty. The medical professors used chemistry to diagnose patients and to develop drugs. The experimental culture that this fostered amongst Edinburgh's students and professors spilled out into other areas and chemistry soon found itself being applied to georgics, mining, bleaching and brewing. The connection that these topics shared with natural history effectively created a situation where the Medical School was the main engine that drove a wide variety of experimentation that was applicable in the laboratory, to classification and to industry. As the next chapter will show, this context allowed Walker to use his knowledge of chemistry to establish himself in the area of mineralogy—a field that was directly relevant to the professors of the medical school and to the improving landlords of the Lowlands.

Chapter 2

Chemical Principles, Doctrines and Systems

Introduction

The main purpose of this chapter is to address John Walker's early chemical education. Like many Scottish natural historians of this time, Walker frequently employed chemistry to investigate the properties and phenomena of the natural objects that he encountered. His use of chemistry is most clearly evinced in a paper he wrote about Hartfell Spa in 1757. Published in the *Philosophical Transactions of the Royal Society*, the chemical terms in this paper are referenced at least six times in the *Oxford English Dictionary*. In addition to this linguistic importance, it provides a unique picture of Walker's early use of chemistry, William Cullen's 'Doctrine of Salts' and the close relationship that existed between chemistry, medicine and natural history during the Scottish Enlightenment. Walker saw his work on the spa as part of a larger chemical 'history' that not only included the teachings of Cullen, but also the writings of mineralogists, assayers and pharmacists whose work spanned the previous three centuries.[1] In order to understand Walker's early chemistry, I present three 'histories' in this chapter. The first is biographical and details Walker's early (1750s) chemical education. Because he was so influenced by William Cullen, specific attention is paid to saline analysis and to Cullen's taxonomic conception of chemical 'principles'. As his 1757 paper addressed the chemical composition of a chalybeat spa, I next present a history of the subject based on Walker's own *Index Librorum*. This section demonstrates that five-principle chemistry (particularly saline analysis) was the main way of determining the composition of mineral water during his early years at the University of Edinburgh. The final section presents a 'compleat' history of Hartfell Spa as represented in his 1757 paper. It details how he employed saline analysis to demonstrate the presence of two alkalis and one acid. I conclude by averring that Walker's experiments were most probably linked to

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* This chapter is a modified version of the following paper: M. D. Eddy 'The Doctrine of Salts and Rev John Walker's Analysis of a Scottish Spa (1749-1761)', *Ambix*, **48** (2001), 137-160. I wish to thank David M. Knight, Andreas-Holger Maehle, William H. Brock, Elizabeth Rainey, Paul Wood and Peter Morris for the helpful comments they gave to me while I was writing it.

[1] In the eighteenth century, the history of chemistry was taught at the beginning of most chemistry courses. This practice, however, was orientated to the needs of the lecturer and mentions many works and authors that do not receive attention today. See J. R. R. Christie, 'Historiography of chemistry in the eighteenth century: Hermann Boerhaave and William Cullen', *Ambix*, **41** (1994), 4-19. M. Beretta, 'The historiography of chemistry in the eighteenth century: a preliminary survey and bibliography', *Ambix*, **39** (1992), 1-10.

Cullen's own work on fixed fossil alkalis and by emphasising the important role played by saline analysis in Walker's later natural history lectures.

I. A History of Walker's Chemical Education

Sources of 'Chymistry'

Walker's early knowledge of chemistry primarily came from three sources: academic contacts in Edinburgh, William Cullen and personal study. Since he did not come from a wealthy family (his father was a divine turned school master), his most viable vocational option was to be a minister in the Established Church of Scotland. To this goal, he enrolled in the University of Edinburgh in 1746 and took a divinity degree in 1749. Alongside his theological studies he had begun to study chemistry and collect minerals from around the Edinburgh area. Mineralogy's close ties with chemistry led him to study the works of Robert Boyle. He then began to expand his knowledge of the subject by moving on to the works of Becher, Stahl, Boerhaave and by attending 'Dr. Plummer's Course of Chymistry in the Year 1749.'[2] Around 1755, this interest in chemistry and natural history placed him in contact with the physician William Cullen,[3] who was appointed to teach chemistry at the University of Edinburgh in 1756.[4] Cullen had actually been involved in the Edinburgh scientific scene for some time and it is possible that he met Walker before he was given an official offer from the University.

In the seven years that followed his graduation, Walker took several tours around Scotland. Several of these forays were taken with Cullen and were linked to procuring plants and minerals that could be used for chemical experiments and pharmaceutical production. Such trips therefore involved *in situ* chemical analysis and allowed Walker to learn a great deal of chemical knowledge directly from one of the leading chemists of the eighteenth century. In addition to such unofficial instruction, he also received official instruction from Cullen at the University of Edinburgh, probably during the winter terms of 1755 and 1756. Based on these classes and the trips that they took together, a firm friendship was formed between them. This friendship was so important to Walker that he considered not standing for

[2] Glasgow University Library (hereafter GUL), MS Gen 1061, f.3.
[3] See the introduction in GUL, MS Gen 1061. These biographical details are also treated in H. W. Scott's biographical introduction to John Walker's, *Lectures on Geology* (London: 1966).
[4] T. Thomson, *The History of Chemistry* (London: 1830), p. 307.

the University of Edinburgh's Natural History Chair in 1778 when he found out that Cullen's son, Henry, was considering the position.[5]

In his early years as a natural historian, Walker's livelihood came from the Church of Scotland. He officially started his ecclesiastical career when he was licensed to be a minister by the Presbytery of Kirkcudbright, Galloway on 3 April 1754.[6] In moving so far from Edinburgh, he formally sought to maintain his scientific connections with the city by joining the Philosophical Society *circa* 1754, the very same time that Joseph Black, another student of Cullen, became a member.[7] Interacting with the Society's distinguished coterie of medics and natural philosophers exposed Walker, both directly and indirectly, to chemistry. In addition to papers given on specific chemical topics, the 'Doctrine of Salts' played a significant diagnostic role in the medical and natural history essays delivered by the members—many of which were given by professors of the Medical School who had been taught chemistry by Boerhaave in Leyden.[8] (Salts also played a significant role in the medical chemistry being practiced in continental Europe at this time. See Plates 2.I and 2.II). Although Cullen lived in Glasgow until 1755,[9] he had been a member of the Society since 1749. This membership no doubt provided him an opportunity to visit his Edinburgh patrons (Lord Kames for instance) and to stay informed on the activities of former students like Walker and Black.[10]

Walker's personal papers and later publications demonstrate that by 1756, he was following in the footsteps of Cullen by actively applying chemistry to natural history. In the mid 1750s, his experiments on several mineral wells finally led to his publishing a paper on the subject in *The Philosophical Transactions of the Royal Society* in 1757. In these experiments, he employed the five-principle chemistry associated with Cullen, Black and other Philosophical Society members. As with many papers during the time, his bore a characteristically prolix title: 'An Account of a new medicinal Well, lately discovered near *Moffat*, in *Annandale*, in the County of *Dumfries*. By Mr. *John Walker*, of *Borgue*-House, near *Kirkudbright*, in Scotland.'

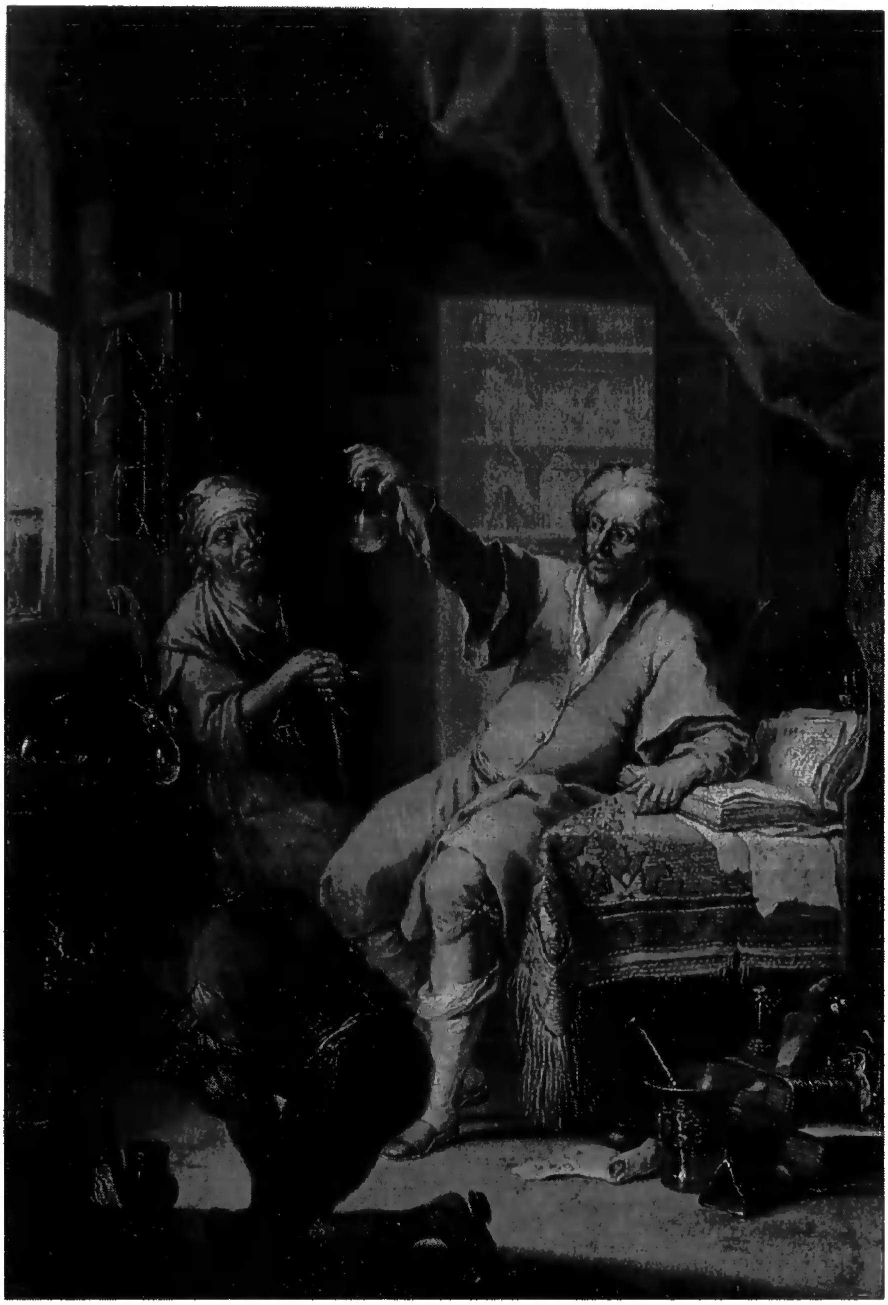
[5] Walker's appointment to the Natural History chair in 1779 was quite a political affair. See J. Thomson, *Account of the Life, Lectures, and Writings of William Cullen, M.D... in Two Volumes*, vol. I (Edinburgh: 1859), 507-508, 729-731; S. Shapin, 'Property, Patronage, and the Politics of Science: The Founding of the Royal Society of Edinburgh,' *BJHS*, 7 (1974), 1-41.

[6] Walker's time in southern Scotland is treated in George Thomson, 'John Walker, an 18th Century Naturalist – His Life and Times in the Rural Parish of Moffat,' *Transactions of Dumfries and Galloway Natural History Society*, 72 (1997), 97-107.

[7] Black read his thesis on *magnesia alba* for the Society on 5 June 1755. It seems that Cullen had also placed Black in contact with Kames. Black wrote to Cullen in August 1755 and apologised for not sending a copy of his thesis sooner because he had given the only legible copy to Kames upon the advocate's own request. See Thomson (1830), 580.

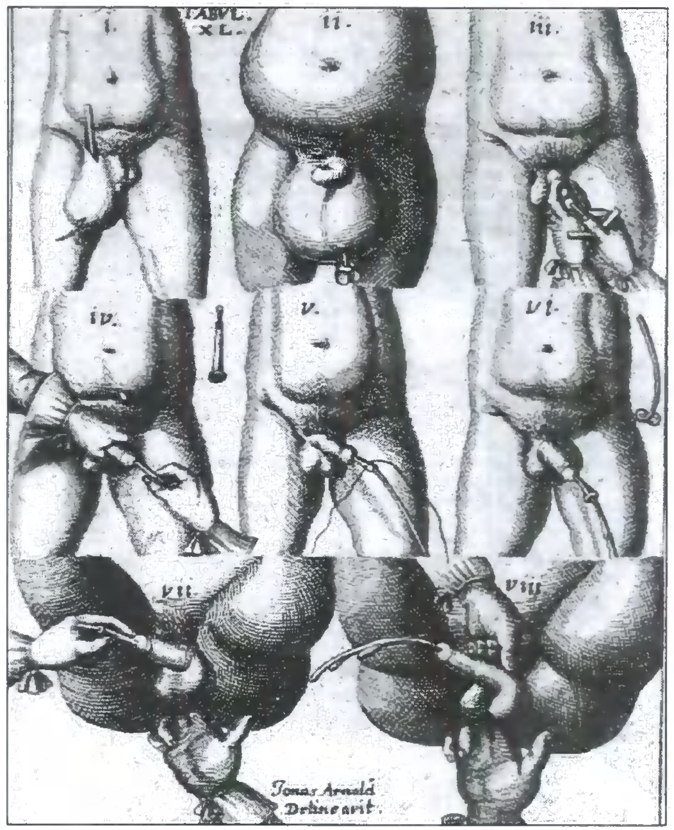
[8] E. A. Underwood, *Boerhaave's men at Leyden and after* (Edinburgh: 1977). Also see R. G. W. Anderson, 'Chymie to Chemistry at Edinburgh,' *RSC Historical Group occasional papers*, 2 (2000), 4-8. A. Clow, 'Hermann Boerhaave and Scottish Chemistry,' in Andrew Kent ed., *An eighteenth century lectureship in chemistry* (Glasgow: 1950), 41-48.

[9] An helpful overview of these years is given in Douglas Guthrie, 'William Cullen, M.D., and His Times,' in Kent (1950), 49-65.

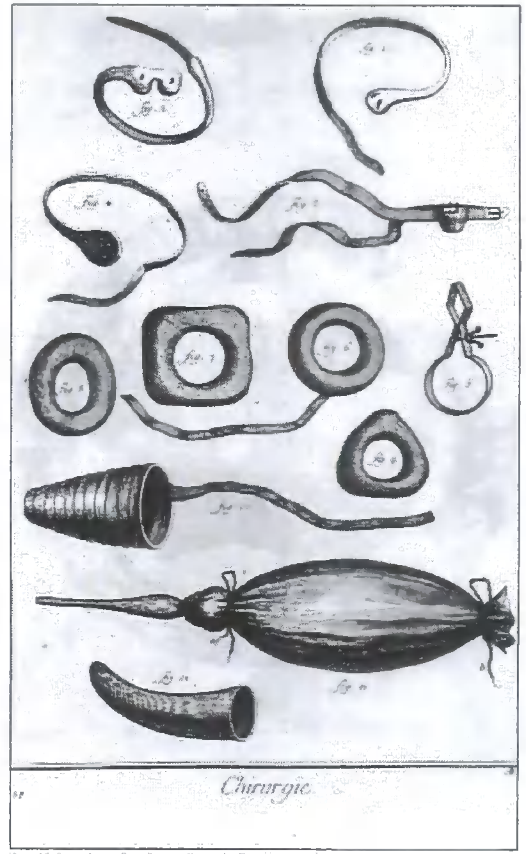


The Uroscopy **(mid 1700s)**
Franz Christoph Janneck (1703-1761)
Eddleman and Fisher Collections
Chemical Heritage Foundation, Philadelphia, Pennsylvania

Throughout Europe, bodily fluids played a strong role in medical chemistry and therapeutics during the seventeenth and eighteenth centuries.



Procedures for exploration and excision of urinary stones...
Johannes Scultetus. Francofurti, *Sumptibus viduae* (Joan. Gerlini : 1666).



Devices to correct medical conditions of the groin...
Antonio Baratti., in Diderot, Denis, *Recueil de planches, sur les sciences...* (Livourne: 1772)

Bladder stones were a terrible problem for Enlightenment physicians and were highlighted by their involvement in the deaths of prominent members of society, Robert Walpole being the best example. During the mid eighteenth century, Edinburgh's Medical School developed saline and terrene based solutions that were injected into the bladder via the urethra (fig. iii, pictured at the left) using a syringe (second instrument from the bottom in picture on the right). Most of the experiments in this process were based on humid analysis that had direct application to the composition of minerals.

The well in question was Hartfell Spa, which was located about thirty-six miles south west of Edinburgh (just outside Moffat). Previous to publication, the paper had been read before the Royal Society of London on 10 February and 3 March of 1757.[11] Because Walker was affiliated with several societies, he might have received feedback from a preliminary reading conducted before the Philosophical Society, the Select Society (Edinburgh), or the Glasgow Literary Society. A few members of these societies had expressed an interest in Moffat's waters earlier because they were already well-known for their medicinal qualities.[12] Contrary to the 'lately discovered' description in the title of the paper, Hartfell Spa was found in 1748 by Lord Hopetoun's mineralogist John Williamson. Nicknamed 'Williamson's Water', Dr. William Horseburgh wrote a paper on it two years later (which Walker states he had read in manuscript form).[13]

A final source of Walker's chemical knowledge was his own personal study. In 1761 he compiled an *Index Librorum*.[14] For each of its one hundred and forty-six entries, he lists the author, title, publication information and page number (if a paper). Many of the entries in the catalogue contain descriptive notes on relevant features of the work and criticisms of the methodology or data used by the author. Over a third of the natural philosophy sources consist of papers in *Philosophical Transactions*.[15] Most of the books were published in London, Dublin, Amsterdam, Paris and Frankfurt. Because it does not contain works that specifically address chemistry, the list at first glance appears to have little to say about the subject. However, books which taught chemistry during this time did not come in the common textbook form that became the standard at the end of the century. A naturalist could learn a great deal about chemistry by reading medical books or works about mineral wells, metallurgy and botany.[16] When one looks at the works in

[10] For a membership list of the Edinburgh Philosophical Society, see R. L. Emerson, 'The Philosophical Society of Edinburgh, 1768-1783,' *BJHS*, **18** (1985), 255-303.

[11] Walker's paper was one of eighty or more papers published in the *Philosophical Transactions* by members of Edinburgh's Philosophical Society between 1748 and 1768. R. L. Emerson, 'The Philosophical Society of Edinburgh 1748-1768,' *BJHS*, **14** (1981), 133-176, on 154-55.

[12] On Moffat's spring waters see: W. A. J. Prevost, 'Moffat Spa in the Seventeenth and Eighteenth Centuries,' *Transactions of the Dumfriesshire and Galloway Natural History and Antiquarian Society, third series*, **43** (1966), 137-146. Moffat's fame had led Andrew Plummer, professor of chemistry in Edinburgh and a member of the Philosophical Society, to publish a paper on it: 'Experiments on the Medicinal Waters of Moffat,' *Medical essays and observations*, **1** (1733), p. 82. Also see H. G. Graham, *The Social Life of Scotland in the Eighteenth Century*, 2nd edition (London: 1928), p. 52; A. Carlisle, *Autobiography*, 2nd ed. (London: 1860), 109-110.

[13] W. Horseburgh, 'Experiments and Observations upon the Hartfell Spaw, made at Moffat 1750,' *Essays and observations, physical and literary* (Edinburgh: 1771), 384-419.

[14] John Walker, *Index librorum 1761*. Edinburgh University Library Special Collections (hereafter EUL), Dc.2.38 Bound MS. Henceforward in this thesis the specific references to individual entries in this book will include the abbreviation 'IL' followed by the bibliographic number assigned by Walker.

[15] This conforms with the general importance of periodicals for those who could not afford folio or quarto sized books or who did not live near large cities with active natural philosophical societies. See T. Broman, 'Periodical Literature,' in M. Franca-Spada and N. Jardine (eds), *Books and the sciences in history* (CUP: 2000), 225-238.

[16] Not much work has been done on the emerging genre of chemistry textbooks in the early to mid eighteenth century. The later part of the century is addressed in A. Lundgren and B. Bensaude-Vincent (eds), *Communicating chemistry* (Canton: 2000).

Walker's *Index* that employ chemistry for classification or diagnostic purposes, one finds that these comprise a significant amount of the collection. For the most part, these works assume a good working knowledge of chemistry and include the names of chemists that Cullen recommended in his lectures.[17] Saline experimentation is a predominant form of analysis. General natural histories are included[18] as well as works specifically devoted to mineral waters, metallurgy[19] and mineralogy[20] and botany.[21] The methodological criticisms made by Walker on several of these demonstrate his commitment to Scottish empiricism. Significantly, none of Linnaeus's works are listed.

William Cullen and the 'Doctrine of Salts'

In his 1664 *Philosophical Transactions* paper on Salts, Daniel Coxe stated the following about his 'chymical' experiments: 'These are not Dreams of a delirous Chymist, but Positions, which I could confirm by an entire *Series* of Experiments: possibly hereafter to be communicated, if upon a strict *examin* I find them worthy of publishing in this Inquisitive and Judicious Age.'[22] Such an earnest defence may seem rather quaint today, but, as Crosland so explained forty years ago, the language of chemistry before the nineteenth century was a complicated affair.[23] Because of their individual conceptions about 'method' and 'fact', these chemists often criss-cross the 'mechanical' and 'philosophical' historiographical categories so frequently placed upon eighteenth century chemistry,[24] a situation which sometimes gives Coxe's conceptual 'delirium' a new meaning.

[17] See Appendices I and II.

[18] J. Hill. *A review of the works of the Royal Society of London; containing animadversions on... Antiquities, medicine, miracles, zoophytes, animals, vegetables, minerals* (London: 1751) IL 71; William Borlase, *The natural history of Cornwall.* (London: 1758) IL 1; C. Leigh, *The natural history of Lancashire, Cheshire, & of the Peak in Derbyshire* (Oxford: 1700) IL 24; J. Morton, *The natural history of Northamptonshire*. (London: 1712). IL 145. R. Plot, *The natural history of Oxfordshire, being an essay towards the natural history of England* (Oxford: 1705) IL 22; R. Plot, *The natural history of Staffordshire*. (Oxford: 1686) IL 23.

[19] A. A. Barba, *The art of metals*, in J. Hodges (ed), *A collection of scarce and valuable treatises upon metals, mines and minerals*...(London: 1738) IL 117; G. Plattes, *A Discovery of subterraneall treasure viz of all manner of mines & mineralls from gold to coal... And also the art of melting, and assaying*.... (London: 1738) IL 118; C. C. Schindler, *L'art d'essayer les mines & les métaux*... (Paris: 1759) IL116; J. Webster, *Metallographica, or an history of metals* (London: 1671) IL 18; T. Houghton, *Rara avis in terris or the compleat miner* (London: 1738) IL 119; J. Kunkel, G. E. Stahl and J. C. Fritschius, [anonymous trans.] *Pyrotechnical discourses*... (London: 1705) IL 122. J. G. Lehmann, *Essai d'une histoire naturelle de couches de la terre... traités de physique, d'histoire naturelle, de mineralogie et de métallurgie* (Paris: 1759) IL 70.

[20] J. Woodward, *An attempt towards a natural history of the fossils of England*.... (London: 1728-29) IL 14; E. Owen, *Observations on the earth, rocks, stones and minerals, for some miles about Bristol, and on the nature of the Hot-Well, and the virtues of its water* (London: 1754). IL 38; J. F. Henckel, *Pyritologie; ou, Histoire naturelle de la pyrite.... ouvrages traduits de l'Allemand* (Paris: 1760). IL 135.

[21] R. Bradley, *Ten practical Discourses concerning earth & water, fire & air, as they relate to the growth of plants.* (Westminster: 1727) IL 115.

[22] D. Coxe, 'A Continuation of Dr. *Daniel Coxe's* Discourse, begun in *Numb. 107.* touching the Identity of all *Volatile Salts* and *Vinous Spirits*; together with two surprising Experiments concerning Vegetable Salts, perfectly resembling the shape of the Plants, whence they had been obtained,' *PT*, 9, no. 108 (1674), 169-178, on p. 173.

[23] M. P. Crosland, *Historical studies in the language of chemistry* (London: 1962).

[24] A. Duncan, *Laws and order in eighteenth century chemistry* (Oxford: 1996). Differing definitions of 'empiricism' within the eighteenth century itself also complicated this situation: M. Beretta, *The enlightenment of matter* (Canton: 1993). See Chapters 2 and 3.

Nowhere is this more evident than in Walker's eighteenth century Scotland.[25] Words like 'Salt' and 'oil' were often used to describe two substances which had properties that were diametrically opposed to each other.[26] For instance, in his 1736 *materia medica* lectures at the University of Edinburgh, this situation once made Professor Charles Alston remark: 'Nay the Fallacy of Chymy is remarkable. Producing the same Principle from the most opposite Vegetables.'[27] Philosophical constructs like 'Salts and Earths' and 'acids and 'alkalys' were used to explain physiological functions, the efficacy of pharmaceutical cures and even the occurrence of natural phenomena, as can be seen in the many papers which employ chemistry in the internationally recognised *Medical Essays and Observations*,[28] the principal organ of the Edinburgh's Medical School and its Philosophical Society. Throughout the century, Scottish chemistry's strong links to industry, medicine and agriculture insured that it remained based on the 'facts' of empirical observation.[29] This commitment to chemical experimentation soon became fused with the Scottish intelligentsia's ambivalent attitude toward hypothetical conjecture and feigned hypotheses.[30] The result was an implicit acceptance of general chemical 'principles' with the overt recognition that they were only constructs that might prove to be incorrect at a later date, a mentality that also governed Walker's later approach to natural history.[31]

Walker's *Philosophical Transactions* paper demonstrates that Cullen's influence over him was quite significant. In fact, at the most basic level, he accepted most of Cullen's chemical teachings.[32] It is therefore necessary to define key terms that laid the foundation for Walker's analysis of Hartfell Spa. Part of Cullen's appeal was that he strove to make chemistry an individual discipline that used unambiguous vocabulary. Key terms like 'system' and 'principle' were at the heart of this effort. Like so many of his contemporaries, Cullen understood the term 'principle' to be a

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[25] Questions regarding aspects of these paradigms are addressed in A. Donovan's 'The Chemical Revolution and the Enlightenment - and a Proposal for the Study of Scientific Change,' in Peter Jones ed., *Philosophy and Science in the Scottish Enlightenment* (Edinburgh: 1988), 87-101. Also see Donovan's, 'William Cullen and the Research Tradition of Eighteenth-Century Scottish Chemistry,' in R. H. Campbell and A. S. Skinner ed., *The origins and nature of the Scottish Enlightenment* (Edinburgh: 1982), 98-114.

[26] W. H. Brock treats the general chemical context of this period in *The Fontana History of Chemistry* (London: 1992), 111-121.

[27] C. Alston, *Introduction to materia medica* (1736). EUL Dc.8.12, ff.19.

[28] Several of its editions were translated into German and French. See *Die medicinischen Versuche und Bemerkungen, welche von einer Gesellshaft in Edinburgh durchgesehen und herausgegeben werden*, (Altenburg: Druck und Verlag P.E. Richters, 1752); *Essais et observations physiques et litteraires de la Société d'Edinbourgh traduits de l'Anlgais, par M. P. Demours* (Paris: 1747).

[29] This situation is contextualised by J. Golinski, *Science as public culture:* (CUP: 1992). See Chapter 2, 'The study of a gentleman'. For more on how Cullen fit 'facts' into a 'system', see J. Thomson (Edinburgh: 1832), vol. II, 94-99.

[30] D. V. Fenby, 'Chemistry during the Scottish Enlightenment,' *Chemistry in Britain*, **22** (1986), 1013-1016.

[31] I have discussed this in M. D. Eddy 'Geology, Mineralogy and Time in Professor John Walker's Natural History Lectures, 1779-1803,' *HS*, **39** (2001), 95-119, on p. 97-99.

taxonomic distinction that did not necessarily represent the ontological composition of the matter it was used to describe.[33] This allowed him to espouse Newton's *hypotheses non fingo* on one hand while disregarding the epistemological incertitude of corpuscular mechanics on the other.[34] He understood the term 'system' to be a pedagogical tool used to present empirical data to students.[35] This definition also had taxonomic overtones and, as Barfoot has stated, although Cullen's 'system', 'implied subject matter of some kind, [it] also referred to the way in which the contents were organised and presented in a general or theoretical way.'[36] At the base of Cullen's 'system' were five 'principles': Salts, inflammables, water, Earths, and metals (Plates 2.III and 2.IV).[37] In his 1748-49 chemistry lectures, he defines these principles:

> [S]alt *is a body soluble in water, fusible in the fire & sapid.* Sulphur *or oil is a body not miscible with water, but volatile & inflammable—to be distinguished from mineral sulphur.* Water *is a body with heat & volatile, but not inflammable & insipid.* Earth *a dry solid body not fusible volatile or inflammable.* Mercury *is fluid, insipid, volatile.*[38]

Inflammables (Sulphur), mercury and Salt (not to be confused with common table salt) were the legacy of Paracelsian chemistry, while Earth, water (Air would be added in the 1750s) and the burning quality of sulphur were conceptually linked to the four elements of alchemy and Greek philosophy.[39] These five principles and the experimental methodology that governed their application to the natural world will be referred to as 'five-principle chemistry' throughout the rest of this thesis. As Donovan has demonstrated, Cullen's five-fold taxonomy presented several classification problems.[40] One of the most pressing was that certain Earths proved to be soluble in water. Such a quality blurred the line between Earths and Salts (an ambiguity which is a good example of the classification difficulties that haunted

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[32] Christie warns that the current typologies do no adequately treat Cullen's multifaceted career. J. R. R. Christie, 'William Cullen and the Practice of Chemistry,' in A. Doig, J. P. S. Ferguson, I. A. Milne and R. Passmore eds., *William Cullen and the eighteenth century medical world* (EUL: 1993), 98-109.

[33] Compare this to P. J. Macquer's definition of a chemical principle: 'This is the name given to substances obtained from compound bodies, when their analysis or chemical decomposition is made.' This is found under the entry 'PRINCIPLE' in his *Dictionary of Chemistry* (London: 1777). Cullen cites Macquer in his lectures and the latter's chemical 'principles' (primary, secondary, proximate and remote) do have taxonomic overtones. Also see Robert Siegfried and Betty Jo Dobbs on 'principle' in 'Composition, a neglected aspect of the chemical revolution', *AS*, **24** (1968), 275-293, esp. page 276.

[34] A. L. Donovan *Philosophical chemistry in the Scottish Enlightenment* (EUL: 1975). See Chapter 2, 'English Natural Philosophy after Newton'. This acceptance of Newton's method and rejection of his underlying epistemology often causes confusion for the historiography of eighteenth century Scottish chemistry. Also see Larry Laudan, *Science and hypothesis* (London: 1981), 86-110, 124-127.

[35] Others used the same assumption to create chemistry tables. See Lissa Roberts, 'Setting the Table: The Disciplinary Development of Eighteenth Century Chemistry as Read Through the Changing Structure of Its Tables,' in Peter Dear ed., *The literary structure of scientific argument* (Philadelphia: 1991), 99-132.

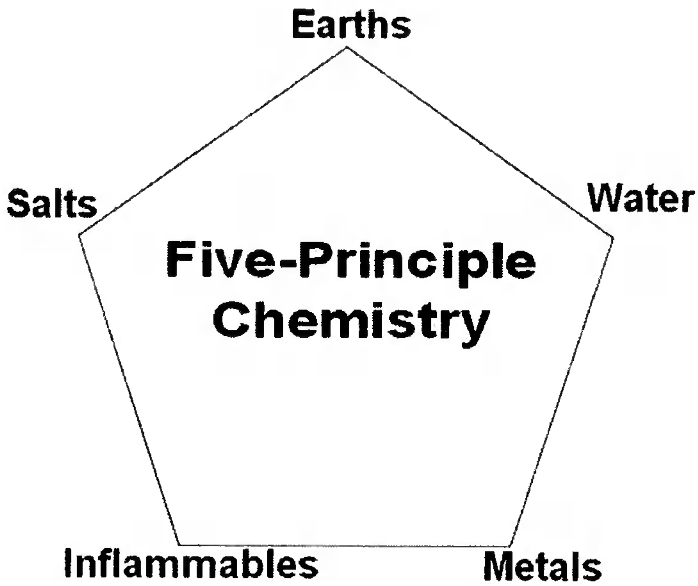
[36] M. Barfoot, 'Philosophy and Method in Cullen's Medical Teaching,' in Doig, Ferguson, Milne and Passmore (1993), 110-132, see page 114.

[37] For the remainder of this essay, the capitalised form of 'Salts' and 'Earths' connotes the philosophical/chemical usage of these terms used during the seventeenth and eighteenth centuries.

[38] Italics are my own. The Royal College of Physicians of Edinburgh Library, MSS C.15, Vol. I, fol. IIr & V.

[39] For helpful discussions of these terms, see L. Abraham, *A dictionary of alchemical imagery* (CUP: 1998).

[40] Donovan (1975), 114-128.



During the mid eighteenth-century, medical chemistry was based upon five 'principles' (above). This chemical formulation was then translated into mineralogical systems in a variety of ways which laid the foundation for classification categories. An excellent example of this occurrence can be seen in the excerpt below taken from J. G. Wallerius' immensely influential *Mineralogie* (1753).

4 MINÉRALOGIE.

§. 3.

Les Minéraux ſe diviſent en cinq claſſes principales.

La premiere eſt des Terres, (*Terræ.*) dont les particules ne ſont pas liées, & qui peuvent être délayées & diviſées par l'eau.

La ſeconde, des Pierres, (*Lapides.*) dont les particules ſont étroitement liées les unes les autres, & ne peuvent être ni diviſées ni délayées par l'eau.

La troiſieme, des Sels (*Salia.*) qui ont la propriété de ſe diſſoudre dans l'eau & de produire de la ſaveur.

La quatriéme, des Soufres & des Bitumes, (*Sulphura & Bitumina.*) qui ſe diſſolvent dans les huiles & qui s'enflamment dans le feu.

La cinquiéme, des Métaux, (*Metalla.*) en comprenant ſous ce nom & ceux qui ſont parfaits, & les imparfaits, dont les propriétés générales ſont d'entrer en fuſion au feu, d'y prendre une ſurface convexe, d'avoir de l'éclat, & d'être les corps les plus peſans de la nature : mais comme les Sels, les Soufres, & les Métaux ne ſe trouvent que rarement ou jamais purs;

Explanation of the Characters. 157

△	Principle of Inflammability.		Calcareous Earth.
▽	Water.	M	Magnesia.
□	Earth.		Earth of Alum.
○	Salt.		Spirituous Oils.
	Acidity.		Unctuous Oils.
+	Acrimony.		Spt. of Wine.
⊕	Vitriol.	MS	Metallic Substance.
	Nitre.	☉	Gold.
⊖	Common Salt.	☽	Silver.
	Acetous Acid.	☿	Mercury.
	Tartar.	♀	Copper.
SS	Sedative Salt.	♂	Iron.
	Sulphur.	♄	Lead. ♄+
	Volatile Sulphur: Acid.	♃	Tin. ♃+
Mir.	Mephitic Air.		Regulus of Antimony.
α	Alkalies in general.		Arsenic
	Fixed Alkali.	B	Bismuth
	Volatile Alkali.	P	Platina
		N	Nickel

++ being the character of Silver with acrimony at its top for Lead, & at its bottom for Tin.

MS copy of Joseph Black's chemical symbols, *circa* 1768.

The principles of Inflammability, Water, Earth, Salt and are pictured on the top left, while the principle Metal (MS) appears in the middle of the right hand column. Walker's personal notebooks indicate that he used the same symbols as Black.

Marco Beretta (ed), *A select catalogue of the Waller Collection* (Uppsala: Acta Universitatis Upsaliensis, 1993), 164.

most chemical taxonomies at this time).[41] Despite its shortcomings, Cullen actively promoted the five-principle system of chemical classification in his lectures during the 1750s. It was then adopted by many of his students, including Black who, aside from adding the new category of 'Air', gives similar chemical divisions in his 1767 lectures.[42]

When Walker was learning chemistry in the early 1750s, Cullen was devoting a considerable amount of time to understanding the Salt principle. Such a focus on saline experimentation was also being pursued in France and the German principalities during this time period.[43] Cullen felt that Salts were the most important of the five classes. This belief was linked to the residual humoural approach to medical therapy that strongly influenced the Medical School's curriculum. In a paper delivered in 1753 to the Philosophical Society of Edinburgh, he stated: 'I proceed to the doctrine of salts. As these... are more necessary to the understanding [of] the properties of other bodies than any one of the other classes are.'[44] At the time of this statement, the general concept of a 'Salt' dominated most forms of humid analysis,[45] not only in Scotland, but also in mainland Europe. This often caused confusion because chemists often did not agree on basic saline composition or classification (a problem that had been around since Paracelsus). Indeed, an anonymous 1674 *Philosophical Transactions* paper in Walker's *Index* voices the questions that Cullen asked fifty years later: 'The *Saline* Principle, being that whereon I intend chiefly to insist, I shall enquire, whence it derives its Original? what subject doth most resemble? or with what 'tis most nearly allied?'[46]

As result of such confusion, Cullen sought to establish a clear saline taxonomy. Like many chemists of his day, he divided Salts into two 'species': *Simple Salts* and *Compound Salts*. This sort of 'simple' and 'compound' taxonomy was quite common during the mid eighteenth century. In Edinburgh, there were not only simple and compound Salts, but the terms were also applied to different types of minerals and drugs. Cullen's simple Salts were those that made either acidic solutions or alkaline solutions. Compound Salts were produced by combining one

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41 For instance, see Oldroyd on the changing conception of an 'Earth': D. R. Oldroyd, 'Some Phlogistic Mineralogical Schemes, Illustrative of the Evolution of the Concept of 'Earth' in the 17th and 18th Centuries,' *AS*, **31** (1974), 269-305.
42 Thomas Cochrane, *Notes from Doctor Black's lectures on chemistry 1767/8*, Douglas McKie (ed), (Wilmslow: 1966).
43 F. L. Holmes, *Eighteenth-century chemistry as an investigative enterprise* (Berkeley: 1989), 49-59. A. Donovan, *Antoine Lavoisier* (CUP: 1993), 74-109. N. E. Emerton, *The scientific reinterpretation of form* (London: 1984), 209-232. M. Boas, 'Acid and alkali in seventeenth century chemistry', *AIHS*, 9 (1956), 13-28.
44 L. Dobbin, 'A Cullen Manuscript of 1753,' *AS*, **1** (1936), 138-156, on p. 144.
45 See 'SALT' and 'NOMENCLATURE' entries in the revised edition of W Nicholson's *A dictionary of practical and theoretical chemistry* (London: 1808).
46 [Anon.], 'Some Observations and Experiments about *Vitriol*, tending to find out the nature of that substance, and to give further light in the Inquiry after the Principles and Properties of other Minerals...,' *PT*, 9, no 103 (1674), 45. [*IL* 53].

acidic Salt and one alkaline Salt, which therefore made it *neutral*.[47] Aside from his own experiments, his work on this subject was influenced by the physician Hermann Boerhaave[48] and the chemist and physician Georg Ernst Stahl[49]—a trait exhibited by most of the chemists in Edinburgh's medical school. He also held the saline experiments of Daniel Coxe and Fredrick Slare in high regard and Walker's *Index* demonstrates that the he too valued the work of these two men.[50] For many Scottish chemists (including Cullen, Black and Walker) the terms 'acid' and 'alkali' were shorthand for 'acid principle' and an 'alkali principle'.[51] The actual material cause of these principles was not known.[52] Alkalis were further divided into those that were *fixed* (stable when left alone) and *volatile* (liable to evaporate or decompose on their own when left alone). There were two standard tests for acids and alkalis. The first, and easiest, was the 'palate' test. A chemist simply placed the substance in his mouth and if it tasted 'sweet', it was an alkali. If it was 'sour' or 'bitter', it was an acid. Naturally this test sometimes raised questions of subjectivity and therefore it usually functioned as a preliminary indicator. The second test used a vegetable extract (the syrup of violets being a Scottish favourite). It could be added to a solution directly or by paper sheets on which the solution had been allowed to dry.[53] The presence of an acid turned the extract red and the presence of an alkali turned it blue or green.[54]

II. A History of Chalybeat Spas

Orientations

Since ancient times, spas were believed to possess healing qualities. During the eighteenth century, many physicians recommended spa water because they

[47] See Appendix I. The actual title of Cullen's paper was 'Some Reflections on the Study of Chemistry, and an Essay toward ascertaining the Different Species of Salts' and it was not published until Leonard Dobbin's work (1936) on the subject. The paper's relevance to Cullen's other work is treated in Arthur Donovan, 'Pneumatic Chemistry and Newtonian Natural Philosophy in the Eighteenth Century: William Cullen and Joseph Black,' *Isis*, **67** (1976), 217-228.
[48] H Boerhaave, *Elementa chemiae*, first published in Leyden in 1732 and then in several editions and translations during the eighteenth century. Cullen specifically makes reference to the 'Treatise on Menstruums' in his 'Doctrine of Salts' lecture. One of the first English editions of the book was Timothy Dallow's *Elements of chemistry: being the annual lectures of Herman Boerhaave, M.D... vols. I & II* (London: 1735).
[49] Although Cullen found several of G. E. Stahl's works helpful, he specifically references *Specimen Becherianum* (Leipzig: 1703) in his Salts paper.
[50] Daniel Coxe, 'A way of extracting a *Volatile* Salt and Spirit out of Vegetables...,' *PT*, 9, no 101 (1674) IL 53, 4-8; Coxe, 'A Discourse denying the Præ-existence of *Alcalizate* or Fixed Salt in any Subject, before it were exposed to the Action of the Fire... *viz.* That *Alcalizate* or Fixed Salts extracted out of the Ashes of Vegetables, do not differ from each other: The Same likewise affirm'd of *Volatil* Salts and *Vinous* Spirits...,' *PT*, 9, no 107 (1674) IL 53, 150-158; Coxe, (1674), 169-178.
[51] For English positions on this topic, see Harold Cook, 'Sir John Colbatch and Augustine Medicine; Experimentalism, Character and Entrepreneurialism', *AS*, 47 (1990), 475-505. See esp. the bits that treat Slare and the debate surrounding the definition of an acid and an alkali, pages 494-501.
[52] A situation that remained until the beginning of the nineteenth century. See R. Kirwan, *Essay on Phlogiston, and the Constitution of Acids* (London: 1789).
[53] A test pioneered by Robert Boyle, *Short memoirs for the natural experimental history of mineral waters* (London: 1684/5).
[54] This had become the standard acid test by the end of the eighteenth century and is detailed in A. and C. R. Aikin, *A dictionary of chemistry and mineralogy*, vol. I (London: 1807), 37-39.

believed it dissolved urinary stones.[55] This led many physician-naturalists to see minerals in the same way that they saw the humours of the human body. The spa's composition therefore could be used to 'diagnose' the mineral composition of the ground below. Key to a spa's medical and mineralogical utility was whether or not it was acidic or alkaline. Based on this context, it is interesting to note that the main goal of Walker's 1757 *Philosophical Transactions* paper was to demonstrate that Hartfell Spa contained *both* acid and alkaline 'principles'. More specifically, he held that its acidic composition came from an alum principle and that its alkaline composition came from iron and ochre principles. All of these components were in some way or other associated with metalline qualities. In Britain, wells and springs that contained such qualities (iron being the most popular) were often called *chalybeat* (or *chalybeal*) and in Germany they were called *Acidulæ* or *Sowre-Brunns* (*Sauerbrunnen*).[56] As demonstrated in the pages of the *Philosophical Transactions* articles contained in Walker's *Index*, the chemical composition of chalybeat wells had provided a reoccurring topic of enquiry since the 1660s. These wells were popular because many physicians believed that their metalline Salts were good for various aspects of one's heath. In Walker's case, he was specifically interested in determining the presence of 'iron' because of the medicinal value assigned to it by the Edinburgh medical community.

Walker's *Index Librorum* indicates that he had followed the literature published on chalybeat wells with great interest. Based on the *Index*, it is possible to construct a history of what he held to be the key experiments conducted on chalybeat wells during the seventeenth and early eighteenth centuries. Because the medium was inherently liquid, this history reveals that most prevalent chemical form of analysis used to determine he composition of the water was the 'Doctrine of Salts'.[57] How these Salts eventually came to form the ochre, iron, alum and sulphur traditionally associated with such wells was a subject that continued to be debated until end of the eighteenth century. Since there are so many different saline opinions expressed in these works, I highlight two concepts that laid the foundation for Walker's *Philosophical Transactions* paper: the 'principle' of iron and the concept of saline acidity/alkalinity. The following 'history' first demonstrates that chalybeat spas were thought to be acidic during the late seventeenth century. However, this

[55] A. H. Maehle, *Drugs on Trial: Experimental pharmacology and therapeutic innovation in the eighteenth century* (Amsterdam: 1999), 89-96.
[56] Also see 'CHALYBEATE' entry in J. Worth Estes, *Dictionary of protopharmacology, therapeutic practices, 1700-1850* (Canton: 1990), 44-45.

received opinion changed during the early part of the eighteenth century when the experiments by Frederick Slare proved them to be alkaline. This dual historical importance of acidic and alkaline mineral water composition laid the foundation for Walker's 1757 analysis.

Acidic Chalybeat Spas

Most of the authors in the late seventeenth century *Philosophical Transactions* papers of Walker's *Index* held that the 'bitter' taste of chalybeat waters indicated acidity, which they in turn associated with the presence of a saline metal (usually iron, copper or tin). This composition was specifically addressed in a series of letters and papers that ran in the 1668-1669 issues.[58] The discussion was sparked by a book named *Hydrologia Chymica*, written by William Simpson,[59] which sought to identify the 'cures' associated with a plethora of 'Sanative waters' in England and Europe. As the book also addressed Robert Wittie's work on Scarbrough Spa,[60] Wittie reviewed it in No. 49.[61] The editors responded to this review in No. 51 with a summary of authors who had recently written on the subject. Scarborough Spa received particular attention because it was the primary example used by Simpson and Wittie.[62] They state: '*Dr Witties* undertakes to evince by good Proofs, and manifold indicators, that these *Scarborough* waters have a mixture or tincture of Iron, Allum, Nitre, and probably a small dose of Common Salt.'[63]

The above comments by the editors in No. 51 set off a series of papers that were specifically interested in chemical composition of medicinal wells. Several of these papers that attracted Walker's attention and the *Index* lists them as 'Papers Relative to the Controversy Concerning Scarborough Water'[64] and 'Papers on the Controversy between Dr. Wittie, Foote, Highmore, Concerning Mineral Waters.'[65]

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[57] This made Walker less interested in the role of heat and 'airs'. For the role of the latter in Scottish mineral well analysis, see J. Eklund, 'Of a Spirit in the Water: Some Early Ideas on the Aerial Dimension,' *Isis* 67 (1976), 527-550.
[58] Aspects of the political and pharmacological issues involved in this debate are addressed in N. G. Coley, '"Cures Without Care"– "Chemical Physicians" and Mineral Waters in Seventeenth-Century English Medicine,' *MH*, **23** (1979), 191-214. See specifically pages 199-210.
[59] W. Simpson, *Hydrologia chymica: or the chymical anatomy of Scarbrough and other spaws in Yorkshire. Wherein are interspersed animadversions upon Dr. Wittie's lately published treatise on Scarbrough Spaw* (London: 1669).
[60] Robert Wittie, *Scarbrough Spaw: or a description of its nature and virtues* (London: 1660). Over the next two decades, this book would be amended and published at least three times.
[61] R. Wittie, 'An Answer to *Hydrologia chemica* of William Simpson…,' *PT*, **4**, no 49 (1668-1669), 999-1000.
[62] Wittie published another book on the subject in 1669: *Pyrologia mimica, or, an answer to Hydrologia Chymica of William Sympson* ... (London: 1669).
[63] [Anon.], 'The Former Account of Dr. Wittie's ANSWER TO THE HYDROLOGIA CHYMICA Enlarged,' *PT*, **4**, no 51 (1668-69) IL 49, 1037-140, on p. 1039. Scarbrough Spa had attracted attention of several naturalists during this time. For another example, see Lucas Hodgson, 'A Letter Written by D. Lucas Hodgson, Physician at Newcastle, containing some observations made by him of a *Subterraneanal Fire* in a coal mine near that city', *PT*, **11**, no 113 (1676), 761-766, on p. 764.
[64] EUL Dc.2.38, IL 48.
[65] J. D. D. Beale also contributed to this debate: 'The Cause of Mineral Springs further inquired; by Dr. *J. Beale*, to the Publisher,' *PT*, **4**, no 56 (1668-69) IL 49, 1131-1135; 'Instances, Hints, and Applications, relating to… the Cause or promote the Generation Salt, Minerals, Metals, Christal; Gems, Stones of divers Kinds …,' *PT*, **4**, no 56 (1668-69) IL 49, 1135-1142; 'The Ingenious Reflexions relating to *Medical Springs* Numb. 52…,' *PT*, **5** [issue number] (1670) IL 49, 1154-1164.

Daniel Foot was the first to respond.[66] He was not directly concerned with Wittie's book *per se*. His paper in No. 52 was concerned with a tangential issue. He wanted to know why the composition of mineral waters changed even after they had been hermetically sealed in jars. Such a question led him to consider their saline composition. Although his paper does not make an explicit connection between chalybeat wells and acid, the mineral well is discussed in terms of its acid/alkali composition: '[I]t is as much received, even to become a Cymical Maxime, That acids and Alcaly's mutually operate upon one another to a satiety, to an abating, and (if circumstances correspond) to and utter amission of their former activities, and lastly to a production of a *Tertium neutrum.*'[67] Foot goes on to state that springs which contain 'Metall' are not in such a state of equilibrium because they contain an *acidic* Salt of metal.

This subject is further explored in a letter from Nathaniel Highmore to J. D. D. Beale, written on 17 December 1669 and printed in the in the next issue. Highmore was quite unsatisfied with Wittie's chemical classification and testing methods. In the process of stating his criticisms, Highmore states that Foot erroneously thought that vitriol (sulphur) and iron were two separate constituents. He avers that the situation was quite the opposite: 'Vitriol is the Salt of Iron, and there is no Iron without it.'[68] He defends this assertion by stating that Vitriolic Salt (usually considered to be acidic at the time) deposited on rocks around springs turns to iron when exposed to the sun. He then states: 'Salts in the Earth may combine with different Bodies, and make up several compounded masses, which yet, when dissolved, may communicate the same properties. The Vitriol of Copper makes water acid as well as that of Iron.' The last sentence is extremely important for our discussion because the presence of iron (e.g. Salt of iron) is explicitly linked to acidity. These chemical assumptions set the stage for Highmore's discussion of '*Chalybeate*' waters near the conclusion of the letter: 'Moreover, if I may guess at the Ingredients of those Waters, which we call *Chalybeate*... I think them to be impregnated principally from the Vitriol or Salt of Iron, which is very Volatile.'[69] Highmore was further convinced that the water had iron in it because it turned red upon the addition of bile (a common test for determining the presence of iron). Thus,

[66] D. Foot, 'Some Reflexions Made on the enlarged Account of Dr. *Wittie's* Answer to *Hydrological Chymica* in Numb. 51 of these Tracts; chiefly concerning the Cause of the sudden loss of the vertues of Mineral Waters,' *PT*, **4**, no 52 (1668-69) IL 49, 1050-1055.
[67] Foot (1668-69), 1055.
[68] N. Highmore, 'Some considerations Relating to Dr. *Wittie's* Defence of *Scarborough Spaw* together with a brief Account of a less considerable *Salt-spring* in Somersetsh[ire]: an Account of a Medical Spring in *Dorsetshire*...,' *PT*, **4**, no 56 (1668-69) IL 49, 1128-1131, p. 1129.
[69] Highmore (1668-69), 1130.

based on his understanding of saline composition, Highmore held that that Chalybeat waters were acidic.

By 1700, the acid principle was closely associated with Chalybeat wells, as is clearly illustrated by Charles Leigh's widely read *The Natural History of Lancashire, Cheshire, & the Peak of Derbyshire*. Walker's *Index* entry on this book held it to be 'more conversant in mineral Waters than any other branch of natural history.' Leigh states: 'The *Waters* we shall next consider are the *Acidulae*, or those commonly called *Chalybeats*, with which these countries abound.'[70] Testing for the Salt of iron, or the more ambiguous 'ferrugineous parts', in mineral waters continued to spark interest at the beginning of the eighteenth century. Yet, conflicting assumptions about the saline composition often make it hard to understand just what a given author means by 'iron', especially if he does not state his position on the matter. This problem is evinced by the next chronological source cited by Walker's *Index*. It is a letter published in *Philosophical Transactions* No. 312 during 1707 by Dr. Scipio Des-Moulins. In it he relates a series of tests on a mineral well at Canterbury.[71] Although he states that the water smelled 'ferruginous' and that it turned red when bile was added to it, he does not specifically state that it contained 'iron' and only at the very end does he offhandedly call it chalybeat. This ambiguity towards the presence of 'iron' seems to be unwarranted until one looks at his acidity tests. The three vegetable extracts that he had added turned *green*, *blue* and *violet*.[72] This indicated the presence of an *alkali*, not an acid, and therefore contradicted the received opinion that chalybeat waters were acidic.

'Alkalase' Chalybeat Spas

Des-Moulins's contradiction would soon be re-addressed in a 1713 paper by Dr. Frederick Slare,[73] one of only two chemists of the Royal Society during the early eighteenth century who Cullen thought had any merit.[74] After a brief historical introduction on the German conception of acids, Slare cites how a series of (unstated) experiments conducted by Dr. Jordis, F.R.S., of 'Francford' made him suspect that chalybeat waters were *not* acidic. Using chalybeat water from Sussex

[70] C. Leigh. *The natural history of Lancashire, Cheshire, & of the Peak in Derbyshire* (Oxford: 1700). Walker maintained this book was a continuation of R. Plot's approach laid out in *Then natural history of Oxfordshire* (Oxford: 1705 – 1st ed. in 1677) IL 24.
[71] S. Des-Moulins,. 'Part of a Letter from Dr. *Scipio des-Moulins*, to Dr. *Hans Sloane*, R. S. Secr. concerning a Mineral Water at *Canterbury*,' *PT*, **25**, no 312 (1706-07) IL 77b, 2462-2466.
[72] Des-Moulins (1706-07), 2464.
[73] F. Slare. 'An Examen of the *Chalybeat*, or *Spa-Waters*, called *German's Acid* or *Sowre-Brunns*, or *Fountains*; but prov'd to be of a contrary nature, that is, *Alkalis*...,' *PT*, **2**, no 337 (1713) IL 80, 247-251.
[74] As stated earlier, the other was D. Coxe. See Dr. J. White's notes of Cullen's 1756 lectures that are edited by Andrew Kent and entitled, 'William Cullen's History of Chemistry', in Andrew Kent (1950),15-27. see p. 26.

and Berkshire, Slare then proceeds to conduct several experiments on his own, two of which are the proverbial tests involving taste and bile. Contrary to previous research, Slare claims that chalybeat wells 'if nicely examin'd' actually 'leave a sweetish flavour' on the palate. Likewise, his addition of bile to the waters turned it a 'deep purple' and not red. The evidence provided by his tests forced him to make a conclusion that challenged the previous acidity theory of chalybeat wells: 'Since Mineral Waters, especially those that are Chalybeat, are of such important use to Physick... this had made me judge it a work not unacceptable to Virtuoso's ... to have this Medicine fairly examin'd, its genuine Properties asserted, and what was call'd an Acid to be demonstrated an *Alkali*.'[75] In an act of patriotic humility, he then proceeds to blame this blunder on the Germans, who, in his version of history, had originally linked acids to the 'Iron Species'. Using a series of similar tests three years later at Pyrmont Spa, Slare reconfirmed that chalybeat waters were alkaline. He was particularly keen on validating that they tasted sweet. He does this by giving the water to 'some of his Friends'. He states they originally found it to have a 'sharp taste' and were foolishly content to keep this opinion. But Slare, that salvific enlightener of the scientific palate, converted them away from these erroneous assumptions: 'but when I requir'd them to call back that hasty Assertion, and to consider it better, whether that Taste was really Sour or Acid, they have been forc'd to recant and confess, that the smart and brisk Taste misled them to call it Acid or truly Sour.'[76]

After Slare, it was the dominant view that most chalybeat spas and medicinal wells were alkaline in nature. This was still the case when Walker went to university and when he wrote his paper. For instance, in a 1749 *Philosophical Transactions* paper that describes a spring near a monastery outside of Carlsbad, Bohemia, James Mounsey conjectures that the monks create a 'neutral salt' by adding a mineral acid. Even though Mounsey does not state that the waters are alkaline, most physicians and naturalists who used chemistry believed that making a neutral salt out of an acid required an alkaline agent. Mounsey therefore takes it for granted that the reader will assume that that the waters are indeed alkaline.[77] Finally, in 1756, the year before Walker published his own paper, William Watson's book review in *Philosophical Transactions* of G. C. Springfeld's new treatise on the Carlsbad waters states that the

[75] Slare (1713), 250.
[76] F. Slare, 'A short account of the Nature and Vertues of the *Pyrmont* Waters; with some Observations upon their Chalybeat Quality...,' *PT*, **30**, no 351 (1717-19) IL 82, 564-65.

author's experiments demonstrate: 'that these waters partake always of an alcaline principle… for which reason they ferment with every species of acids.'[78] Based on this 'principle',[79] Springsfeld goes on to demonstrated how an 'alcaline lixivium' can dissolve the gluten that holds together the calcarious matter of urinary stones.

III. A 'Complete' History of Hartfell Spa

Purpose and Definitions

In addition to the mineral water studies in his *Index*, Walker's 1757 paper demonstrates that he was further informed on the subject by experiments he had conducted on water taken from the Spa (Bath), Pyrmont waters and other wells in Lowland Scotland. His main goal with Hartfell Spa was to determine whether or not it was chalybeat. By demonstrating that the spring's waters contained the 'iron principle', he knew that it would attract the attention of physicians seeking to use it for medicinal purposes.[80] In keeping with other improvement-minded Scots from this time period, he is quick to point out some the economical uses of the well. This is consistent with the social, economic and medicinal roles played by medicinal wells during the seventeenth and eighteenth centuries (Plate 2.V).[81] For instance, he argues that the water does not spoil easily when kept in sealed bottles.[82] Since the water from other spas often did not have this longevity, this was a quality that would have appealed to entrepreneurs who might want to sell it abroad or use it as a preservative, especially for milk, as Walker suggests. The results of his experiments would have been readily accepted by his readers because every chemical test that he employed already had been used in well-known publications like the *Philosophical Transactions*. As noted above, Walker's chemistry was based on the 'Doctrine of Salts' espoused by Cullen.

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[77] J. Mounsey, 'Part of a Letter from James Mounsey, M. D. Physician to the Czarina's Army, to Mr. Henry Baker, F. R. S. concerning the *Russia Castor*, the Baths at *Carlsbad*, the Salt-mines near *Cracau*, and various other Notices,' *PT*, **46**, no 493 (1749-50) IL 129, 225.

[78] In this context, to 'ferment' means to fizz. William Watson, 'An Account of a Treatise, *in Latin*, presented and dedicated to the *Royal Society*, intitled '*Gottlob Caroli Springfeld. M. D. &c. &c. commentatio de prerogativa Thermarum Carolinarum in dissolvendo calculo vesicæ præ aqua calcis vivæ*' by *William Watson…*,' *PT*, **49** (1755-56) IL 141, 895-906.

[79] Like Cullen and Walker, Watson represents Springsfeld's 'principle' as a word which not only applied to acids and alkalis but also to other substances such as calcarious matter. See Watson (1755-56), 904-05.

[80] In addition to Horseburgh's and Plummer's papers on Hartfell Spa's potential medicinal qualities, John Rutty also published a paper on it in 1760: 'Of the vitriolic waters of Amlwch, in the Isle of *Anglesey*; with occasional Remarks on the *Hartfell* Spaw, described in the first Volume of the *Edinburgh* Essays and Observations physical and literary, and in the 49th Volume of the *Philosophical Transactions*, and their Comparison with other Waters of the same class,', *PT*, **51** (1760), 470-477.

[81] See R. Porter (ed), *The medical history of waters and spas* (London: 1990) and P. Hembry, *The English spa, 1560-1815* (London: 1990).

[82] A fact that had been noted about Moffat Spa by Plummer in 'Experiments on the Medicinal Waters of Moffat' (1733) and Horseburgh's Experiments and Observations upon the Hartfell Spaw, made at Moffat 1750' (1771).

Hartfell Spa (Near Moffat, Scotland)
David Allen, pen and wash drawing, *circa* 1795
National Galleries of Scotland, Edinburgh

In true empiricist style, he clearly states that his research only functions as a helpful indicator in the larger understanding of spa composition: 'These trials are but few and imperfect, and are no-way sufficient to form an exact account of this mineral water; yet I believe they may afford some conclusions, which may be serviceable in compiling a more compleat history of it.'[83] Nevertheless, despite Walker's commitment to empirical data, his nomenclature is sometimes unclear and definitions for some of his words must be given so that the following presentation of his work does not become confusing. When he uses the word 'iron', he most often means the iron 'principle' that turns blue, purple or violet upon the introduction of galls. The adjective he uses for Salt is 'saline' and his adjectives for Earth are 'terrene' and 'terrestrial'. At the end of the paper, he states that he was was unable to determine whether the iron principle is saline or terrestrial. For this reason, he uses the word 'parts' interchangeably to connote the presence of a Salt or an Earth 'in a very fine and subtile form.' The word 'metalline' is usually a Salt that exhibits metallic properties. Lastly, waters that contain an iron principle are also called 'chalybeat', 'steel waters' or 'ferrugineous waters'. After a series of thirty-seven experiments, Walker concludes that Hartfell Spa contains two forms of 'iron': ochrous earth and a metalline iron. He also demonstrates that the water contains aluminous Salt, sulphur[84] and a 'terrestrial principle' made of 'a light brown-coloured earth'. In what follows, I detail the experiments that led him to this conclusion.

Iron Principle Tests

Since he was interested in demonstrating that the well had chalybeat qualities, Walker first tested for an iron principle. He initiated the tests by consulting his palate. Unlike many previous naturalists who characterised chalybeat water as either bitter or sweet, Walker held that the water tasted both acidic and 'astringent'. He then performed two vegetable extract tests, one which used balaustine-flowers and another which used pomegranate-flowers. These tests turned blue, thereby demonstrating that the water was dominantly alkaline.[85] He next tested for the iron principle by adding 'some pieces of galls'.[86] These turned deep blue and Walker

[83] John Walker, 'An Account of a new medicinal Well, lately discovered near *Moffat*, in *Annandale*, in the County of *Dumfries*. By Mr. *John Walker*, of *Borgue*-House, near *Kirkudbright*, in Scotland', *PT*, (1757), 117-147, page 111.
[84] The importance of Sulphur to saline analysis is treated in the following *Philosophical Transaction* papers (some previously previously cited from Walker's *Index*). [Anon.], 'Some Observations' (1674), 44. [Anon.] (1674), 66-69 and 72-73. Coxe (1674), 152; (1674), 176. Foot, (1668-69) 1055. Des-Moulins (1706-07), 2462-3 and 2465. Slare (1713), 247.
[85] This was a common test, for example see Des-Moulins, (1706-07), 2464.
[86] Also called galla, 'gall nuts' and 'gall balls', these were used in medicinal tonics and as antidiarrheals: '[A] reaction of tree bark tissues to the secretion of larvae of gall wasps as they emerge from eggs laid in oriental oak or dyer's oak.' Estes (1990), 87. Galls were a common test and can be traced most of the previously cited mineral water papers in the *Philosophical*

concludes: 'the water of this Spaw contains a far larger proportion of iron than most.'[87] To further confirm the presence of the iron principle, Experiments 12-16 tested the water's 'cremor', the crust and/or foam that formed at the top of the residual water when it was distilled.[88] His first 'experiments' simply observe the external appearance of the cremor. Its 'shining chalybeat colour' indicated that it contained the iron principle, which Walker's former tests had demonstrated to be alkaline. Therefore, in his next experiments, he added two alkalis, Oil of Tartar (fixed) and Sal Ammoniac (volatile), to demonstrate that the cremor is also alkaline. Since these alkalis did not separate the cremor, like an acid would have done, Walker concluded that the cremor was indeed alkaline.

Some of Walker's tests were not performed on the spa water itself. He used several additional experiments that acted as controls for the various tests that he employed to determine the content of the spa water. Thus, as noted above, he used two vegetable extracts to make sure the water was alkaline. He reconfirmed that his galls were testing for the iron principle by adding them to a solution of Sal Martis (Vitriolum Martis), an acid known to contain the Salt of iron. To double-check his cremor tests, he exposed Sal Martis and an unnamed 'infusion of iron in common water' to air for some time. Both of these formed a bluish cremor, thus confirming Walker's iron principle tests upon the spa cremor. Listed below is a table of the tests Walker associated with testing for the iron principle.

Iron/Alkaline Experiments			
Test	**Agent**	**Medium**	**Positive Indicator**
Iron Principle Test	Galls	Spa Water	Turns Blue
		Sal Martis[89]	*Turns Blue*
Iron Principle Test	Air	Spa Cremor	Turns Chalybeat Colour Develops Blue, Purple and Violet Blotches
		Sal Martis Cremor	*Turns Bluish Colour*
Iron Principle Test	Heat	Spa Cremor	Turns Chalybeat Colour
Fixity Test	Heat	Spa Cremor	Remains Intact
Acid/Alkali Test	None	Spa Water	Tastes Bitter/Sweet
Acid/Alkali Test	Balaustine-Flowers (Vegetable Extract)	Spa Water	Turns Red/Blue
Acid/Alkali Test	Pomegranate-Flowers (Vegetable Extract)	Spa Water	Turns Red/Blue
Acid/Alkali Test	Sal Ammoniac[90] (Volatile Alkali)	Spa Cremor	Cremor Separates/Unaffected
Acid/Alkali Test	Oil Tartar p. d[91] (Fixed Alkali)	Spa Cremor	Cremor Separates/ Unaffected

Transactions. Highmore (1668-69), 1128, 1131. Des-Moulins (1706-07) 2463-4. Slare (1717-19), 565. Also see Boyle (1684/5), 36.

87 Walker (1757), 123.

88 The *OED* gives the following definition: 'a. A thick juice or decoction; a liquid of this consistency: a broth pap. b. By erroneous association with F. *crème*, CREAM, a scum gathering on the top of a liquid.' It then cites page 128 of Walker's 1757 *Philosophical Transactions* article.

89 Italics indicate control tests.

90 Several of Walker's *Philosophical Transaction* used Sal Ammoniac to test medicinal waters. [Anon.], 'Some Observations', (1674), 44. [Anon.], 'A Continuation', (1674), 68. Coxe (1674), 4. Hodgson, 'A Letter Written by D. Lucas Hodgson (1676), 761-762. Slare (1713), 251.

91 Walker's *Philosophical Transactions* articles also used Oil of Tartar. [Anon.], 'Some Observations' (1674), 45; Coxe (1674), 177; Des-Moulins (1706-07), 2463, 2464. Slare (1713), 251.

Ochrous Earth Tests

The sole presence of the iron principle would have made chalybeat well composition a rather simple affair. However, there was a complication. When exposed to air, chalybeat waters not only produced the 'iron' cremor at the top (which was to be expected), they also produced ochre clumps that settled at the bottom of the liquid. Walker held these clumps to be ochreous because of their yellow colour.[92] By Walker's time, the presence of such ochreous clumps served as a simple visual test for determining chalybeat waters, as he states: 'All chalybeat waters separate their ochrous parts, when exposed some time to the air.' Instead of waiting several hours for the ochre to coagulate, the yellowish colour associated with it could be prematurely induced by the addition of the fixed alkalis Saccharum Saturni (sugar of lead) or Oil of Tartar. Walker must have realised that his use of ochre inducing tests had the potential of attracting criticism because he goes on to state: 'but this separation is made sooner by the commixture of several kinds of salts.'[93] These Salts are the same Saccharum Saturni (Sugar of Lead) and Oil of Tartar that he originally used to test for the presence of ochre. Thus, he is not only using them as indicators, but also as coagulant.

Aside from the double use of Saccharum Saturni and Oil of Tartar, the fact that 'ochrous parts' coagulated into 'many small yellow terrene *nebeculæ*' of 'ochrous earth', implicitly meant that there was something in the water from the very beginning that was predisposed to forming ochre. Since the only alkaline dissolvent in the waters that Walker could chemically identify was Salt of iron, he classified ochre under the iron principle. For this reason, he used the distinction 'ochreous parts' and 'ferrugineous parts' interchangeably. This ferrugineous classification was further supported by the fact that after the ochre was precipitated, the remaining water did not tincture when galls were added. Even though Walker held the ochreous parts, the Saccharum Saturni and the Oil of Tartar all to be *alkalis* (he even referred to the former as the 'alkaline oil') he does not address how these two substances interact with the iron principle (also alkaline) to form ochre. It does seem that Walker recognised this conceptual problem because he devoted almost two pages to explaining how the addition of Oil of Tartar sometimes produced different results. He admits: 'yet I could not be so positive as to the oil of tartar, which I suspected to

[92] The significance of ochre (oker, ocker or ocher) in regard to mineral water or saline analysis is addressed in the following *Philosophical Transactions*. [Anon.], 'Some Observations' (1674), 42-43, 45. Foot, (1668-69), 1054; Slare, (1717-19), 569.
[93] Walker, 'An Account of a new medicinal Well', on p. 125.

have been long kept.'[94] This being case, the problems associated with the artificial coagulation of ochre still did not effect his overall argument for the formation of ochreous earth because it formed naturally upon distillation and the addition of common water.

Yet, there is another key issue raised in the ochre experiments. It has already been noted that Walker used a chemical taxonomy similar to (if not the same as) William Cullen's. This system was inherently weak on distinguishing whether or not certain dissolvents were really a Salt or a microscopic Earth. It is for this reason that Walker suggests (using a dependent clause) that the ochreous *nebeculæ* are terrene (and, therefore, implicitly not saline): 'for *if* these ochreous parts be altogether terrene, as they appear to be, and exist in the water unconnected with any other principle, *then* it must happen that as these parts are uniformly diffused thro' the water, in which they are suspended as in a menstruum.'[95] This is why he concludes that the coagulated ochreous 'parts' are *earth*. He states that water contains, 'two different principles of iron, both which are fixed. The one, which is the ochreous earth, it is true *minera ferri*, and, altho' it be a crude mineral, exist in the water in a very fine and subtile form.'[96] Thus, one principle of iron (presumably Salt of iron) had formed the ferrugineous cremor and the other (unnamed) had formed ochreous Earth. With this conclusion, Walker pushed the definition of an Earth into the realm of Salts (or vice versa) in that it could be dissolved in water without being seen by the naked eye.

Ochreous/Alkaline Earth Experiment

Test	Agent	Medium	Positive Indicator
Iron Principle Test	Galls	Spa Water	Turns Blue
Ochreous Earth Test	Air	Spa Water	Turns Yellow
Ochreous Earth Test	Common Water	Spa Water	Precipitates and Turns Yellow
Ochreous Earth Test	Saccharum Saturni	Spa Water Nebeculæ	Turns Yellow (or lactescent)
Ochreous Earth Test	Oil of Tartar	Spa Water Nebeculæ	Turns Yellow
Ochreous Earth Precipitator	Saccharum Saturni[97] (Fixed Alkali)	Spa Water	Precipitated Ochreous Earth
Ochreous Earth Precipitator	Oil of Tartar (Fixed Alkali)	Spa Water	Precipitated Ochreous Earth

Aluminous Salt Tests

Unlike the alkaline principle associated with Hartfell Spa's ferrugineous parts, the well also contained an acid principle: 'From these experiments we infer, that this mineral water contains both an alkaline and an acid principle ... the latter

[94] *Ibid.*, 127.
[95] *Ibid.*, 128. Italics added.
[96] *Ibid.*, 141.
[97] Des-Moulins, (1706-07), 2464.

[consisting] of the aluminous salt.'[98] Walker's 'quest of alum' is found in experiments 17 through 33.[99] It must be remembered that at the beginning of the paper, he noted that the water tasted both acidic and 'astringent', thus indicating the presence of both an acid and an alkali principle. To further investigate this quality, he added sweet (e.g. fresh) milk to both fresh and 'elixated' spa water (e.g. spa water from which he removed the Salt of iron and ochreous earth). The milk coagulated in both tests, thereby demonstrating that the water contained an acid principle independent of the alkaline principle. However, Walker notes that the ratio between the milk and water must be four to one in order for the test to work properly. Too much milk or too much water reduced the likelihood of coagulation: 'I have heard it confidently averred that this mineral water did not at all curdle milk; which I suppose, has been thro' a mistake in the experiment, in adding too large a proportion of milk to the water.'[100] He made this assertion implicitly to defend the fact that he held both an alkali and an acid principle to be present in Hartfell Spa.

Walker's milk tests confirmed the fact that there was an acid principle in the Spa water, but nothing more. The only other evidence that suggested the presence of alum was the fact that his palate had determined the water tasted 'aluminous'. To further prove the presence of alum, he performed two more experiments. After boiling the spa water several times to remove its ferrugineous parts, he boiled all water completely away so that a brown, crystallised Salt remained on the bottom of glass. This brown Salt was then subject to two acids: Spirit of Vitriol and vinegar. Since the Salt did not effervesce (as an alkali would have done), this test indicated that it was an acid. He then placed the Salt on a red-hot iron, an experiment used specifically to test for alum. The Salt itself only calcined, but, when powdered and added to the iron, it ran 'together in a cinder.' This result allowed him to conclude that the Salt was aluminous: 'as it is peculiar to an aluminous salt to liquify in some degree with fire, so we see, that this was evidently the case with this salt.'

As with his tests for the iron principle, Walker also performed a series of experiments to verify the validity of his acid principle and aluminous Salt tests. He reconfirmed the milk test by performing the same experiments on a mixture of spring-water (presumably devoid of any contaminants) and alum. All of these

[98] Walker (1757), 137.
[99] Alum (also spelled Allom and Allum) had been acknowledged to be part of many medicinal wells since chemical experiments were applied to their waters. For instance, the anonymous 1674 *Philosophical Transactions* paper in Walker's *Index* states, 'But first, I cannot but take notice of the great affinity that is between *Vitriol*, *Allom*, and *Mineral Sulphur*'. [Anon.], 'Some Observations' (1674), 47 (also see pages 71-73 in the same volume). The presence of alum also features in the *Index's* 1668-1670 *Philosophical Transactions* papers on medicinal wells. See: [Anon.], 'An account of two Books,' *PT*, 4 (1668-69), 1037 and Highmore (1668-69), 1128.
[100] Walker (1757), 133.

yielded the same levels of coagulation as the corresponding tests upon the Spa water. Mixing the aluminous Salt into spring water, he reconfirmed that alum was an acidic principle by obtaining a red tincture from a syrup of violets infusion and by procuring 'some bubbles of air' from the addition of Oil of Tartar. He also demonstrated the vestigial remains of the iron principle. Thus, a 'lactescent cloud'[101] obtained upon the addition of Saccharum Saturni demonstrated a trace of ochre and a blue tincture produced by galls revealed the lingering presence of the iron principle.

Aluminous/Acidic Experiments

Test	Agent	Medium	Positive Indicator
Acid/Alkali Test	None	Spa Water	Tastes Bitter/Sweet
Acid/Alkali Test	Syrup of Violets	Distilled Spa Salt Mixed in Spring Water	Turns Red/Blue
Acid/Alkali Test	Milk[102]	Elixated Spa Water	Coagulation/Unaffected
Ochreous Earth Test	Saccharum Saturni (Alkali)	Distilled Spa Salt (Acidic) Mixed in Spring Water	Turns Yellow (or lactescent)
Acid/Alkali Test	Oil of Tartar (Fixed Alkali)	Distilled Spa Salt (Acidic) Mixed in Spring Water	Effervescence/No Effervescence
Acid/Alkali Test	Vinegar (Acid)	Distilled Spa Salt (Acidic)	No Effervescence/Effervescence
	Spirit of Vitriol[103] (Acid)	Distilled Spa Salt (Acidic)	No Effervescence/Effervescence
Alum Test	Red Hot Iron	Distilled Spa Salt	Liquefies and Bubbles
Iron Principle Test	Galls	Distilled Spa Salt Mixed in Spring Water	Turns Blue

Conclusion

This chapter has sought to explain Walker's early knowledge of chemistry by presenting three chemical 'histories' relevant to his 1757 *Philosophical Transactions* paper about Hartfell Spa. The first 'history' detailed his chemical education. Specific attention was drawn to William Cullen, the Philosophical Society of Edinburgh and Walker's *Index Librorum*. The second section concentrated on the history of chalybeat spas as portrayed in the works of the *Index*. Specific attention was given to the 'Doctrine of Salts' and the iron principle. The third section presented a 'compleat' history of Hartfell Spa as represented in his 1757 paper. These histories present several points worthy of consideration. The first is that Walker's chemical training was more extensive than hitherto known and was a product of the Scottish experimental epistemology that valued classification and eschewed theory. Such an

[101] The *OED* cites Walker's usage of this word in his paper (page 135) and defines it as: 'Becoming milky; having a milky appearance.' It also cites his paper's use of 'lactescency' (page 124) and defines it as 'A milky appearance; milkiness.'
[102] There are a two *Philosophical Transaction.* papers on this subject listed in Walker's *Index*. Slare (1713), 249. Slare, (1717-19), 565.

approach to 'systemising' chemistry was methodologically similar to the Linnaean taxonomy that was also seizing natural history. As Walker's later lecture notes demonstrate,[104] Cullen's conception of a 'system' (both for medicine and chemistry) and Linnaeus's 'system' for natural history provided a shared methodological base for arranging the data generated by these interlocking disciplines.

A second point raised by this chapter is that Walker's early experiments favoured humid analysis (as opposed to analysis by fire). This was linked to the fact that he accepted the strong emphasis that Cullen placed upon the 'Doctrine of Salts'. From Walker's experiments, it is clear that he was testing the taxonomic limitations of Cullen's saline classification. This makes him, to use a modern term, part of a broader 'research program' during the 1750s which was centred around Cullen and which sought to use the Doctrine of Salts to produce pharmaceuticals and to improve Scottish industry (particularly the bleaching of linen and the production of common salt).[105] Cullen was quite keen to argue that fixed alkalis could not only be obtained from plants (which was the prevalent practice), but also from fossils (minerals). Walker's 'Salt of Iron' (a fixed alkali) experiments on Hartfell Spa only served to reconfirm Cullen's belief that fixed fossil alkalis could occur naturally. The additional boon of Walker's experiments was that they demonstrated that such spas existed in Scotland. This meant that they could be made to serve the demands of Scottish industry, a significant point when one considers that the alkali used to purify sea salt and to dye Scottish linen came from abroad. Such a discovery most definitely would have pleased the Earl of Hopetoun. As the laird of Moffat, the nearest town to Hartfell, he would have benefited economically from the reputation of the waters. Furthermore, Walker's chemical analysis of Hartfell Spa is probably how he later became the scientific advisor responsible for the Hopetoun family's coal mines and for the agricultural improvements they made on their lands.[106]

Walker's 1757 research does present some ambiguities. Most notably, he does not explain how the Salt of 'iron' and 'ochreous' Earth can be metallic and alkaline at the same time. He also does not demonstrate whether ochre is terrene or saline. Yet, despite such ambiguities, one thing remains clear: the 'Doctrine of Salts' was not simply *a* system that governed his humid analysis, it was *the* system—not

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[103] Slare (1713), 251.
[104] For instance see the section entitled 'A general view of its literary history' in *Notes and Lectures on Natural History,* vol. I (*circa* 1789). EUL, Gen 50. This is a set of bound MS notes taken during Walker's natural history lectures at the University of Edinburgh. They are attributed to Walker's student T. Johnson.
[105] Thompson, *William Cullen,* vol. I, 74-82.
[106] This connection is briefly treated in M. D. Eddy, 'James Hope Johnstone, third Earl of Hopetoun (1741-1816),' in the *New Dictionary of National Biography* (Oxford: forthcoming 2004).

only for Walker, but also for Cullen. As such a prominent feature of mid-eighteenth century Scottish medicine and natural history (and European chemistry for that matter), this 'system' deserves more attention than it has hitherto received.[107] As will be seen in the following chapters, Walker employed five-principle chemistry all the way up to the end of the century and his knowledge of the subject would eventually lead him to classify minerals on the basis of chemical characteristics. During his tenure as Edinburgh's Professor of Natural History (1779-1803), he actively endorsed the use of chemical analysis when lecturing on botany, mineralogy and geology. Chemistry permeated his natural history career because it provided data that could be used to classify natural objects. As a tool for examining properties and phenomena, the 'Doctrine of Salts', even more so than theories of heat, proved to be the most practical chemical 'system' for Walker's pursuit of natural history even after the new French nomenclature was introduced at the end of the century.

[107] A general point emphasised in Holmes (1989), especially in his chapter on saline analysis, 31-59.

Chapter 3

From Chemistry to Mineralogical Classification

Introduction

Although the time that Walker spent as Edinburgh's Professor of Natural History (1779-1803) has been addressed by several studies,[1] the previous thirty years that he spent 'mineralising' have been virtually ignored. The situation is similar for many of the well-known mineralogists of the eighteenth century and there is a lack of studies that address how a mineralogist actually became a mineralogist.[2] As Alfred Whittaker's fascinating article on Karl Ludwig Giesecke has recently shown,[3] the reasons for this are many; however the most common problem is the lack of accessible primary material. Using Walker's early career as a guide, this chapter seeks to detail the making of an eighteenth-century Scottish mineralogist. The time frame under examination begins with Walker's matriculation at the University of Edinburgh in 1746 and it ends with his being appointed professor in 1779. The first section demonstrates that his early mineralogical education at the Medical School and under William Cullen was closely linked to chemistry. The second section shows how he used chemical characters to classify minerals and to criticise the systems of Linnaeus, Da Costa, Wallerius and Cronstedt. Because Walker needed many 'fossil' samples to test the viability of his chemical mineralogy, the final

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[1] Walker's time in this position has been detailed in M. D. Eddy, 'Merely a Natural History of the Earth: Geology, Mineralogy and Time in John Walker's University of Edinburgh Natural History Lectures', *HS*, **39** (2001b), 95-119; C. W. J. Withers, 'Improvement and Enlightenment: Agriculture and Natural History in the Work of the Rev. Dr. John Walker (1731-1803)', in *Philosophy and science in the Scottish Enlightenment*, Peter Jones (ed), (Edinburgh: 1988), 102-116; G. Taylor, 'John Walker, D.D., F.R.S.E. 1731-1803. Notable Scottish Naturalist', *Transactions of the Botanical Society of Edinburgh*, **38** (1959), 180-203; John Walker, *Lectures in geology: Including hydrography, mineralogy, and meteorology with an introduction to biology by John Walker*, H. W. Scott (ed), (London: 1966).

[2] Studies that address the actual practice of seventeenth and eighteenth century mineralogy in detail are few. Some of the following sources, however, give a helpful overview: H. Torrens, 'Early Collection in the Field of Geology', in *The Origins of Museums: The cabinet of curiosities in sixteenth- and seventeenth-century Europe*, O. Impey and A. MacGregor (eds), (Oxford: 1986), 204-213; W. E. Wilson, 'The History of Mineral Collecting 1530-1799', *MR*, **25** (1994), 1-264; W. C. Smith, 'Early Mineralogy in Great Britain and Ireland', *Bulletin of the British Museum (natural history), historical series*, **6** (1978), 49-74; A. Livingstone, *Minerals of Scotland: Past and present* (Edinburgh: 2002).

[3] Alfred Whittaker, 'Karl Ludwig Giesecke: His life, performance and achievements', *Mitteilungen der Österreichischen Geologischen Gesellschaft*, **146** (2001), 451-479.

section details how he used tours, patrons and correspondents to built his mineral collection.

I. Educating a 'Fossilist'

University of Edinburgh

As was mentioned in Chapter 2, Walker studied at the University of Edinburgh from 1746 to 1749. Although his official course was divinity, he also studied natural philosophy, chemistry and possibly botany. During this time, the word 'mineral' and 'fossil' were used interchangeably to describe objects that were dug out of the ground. Such a broadly based definition meant that a range of fields like metallurgy, chemistry, georgics and pharmacy influenced mineralogy. As Scotland had no mining academies, mineralogy was actually treated in the *materia medica* and chemistry course offered in the Medical School—particularly in the lectures of Charles Alston, Andrew Plummer, and later, William Cullen.[4] By the mid 1750s, Edinburgh's Medical School had become one of the best places in Britain to learn mineralogy. As many of the professors had studied under Herman Boerhaave at the University of Leiden,[5] they used experimental chemistry to examine biological processes and to develop new pharmaceuticals.[6] The chemical language and characters used in their experiments exerted a strong influence on the practice of botany and mineralogy at the University for the entire century.

Nowhere is the influence of chemistry more clear than in a manuscript written by Walker sometime after 1795. Entitled *Systema Fossilium*, it presented his classification of 'fossils' and was based on research that he had conducted over the past fifty years. In its introduction he recounts his early mineralogical education:

> *I began to collect Fossils in the Year 1746 when attending the Natural Philosophy Class, and was first led to it, by the Perusal of [Robert] Boyle's Works, and especially his Treatise on Gems...[I] often traversed the Kings Park, the Sea Shores between Crammond & Musselburgh, and visited the Quarries & Coalleries near Edinburgh, but had not Book at the Time, to direct [me] concerning the Species of Fossils, but Woodward's Catalogues. After studying the Works of Boyle, Becker, Stahl, Boerhaave, & some others, I attended Dr. Plummer's Course of Chymistry in the Year 1749, and became still fonder of Mineralogy.*[7]

[4] For instance, see Alston's *Lectures on the materia medica containing the natural history of drugs*... John Hope (ed), (London: 1770).
[5] These men are treated in: E. A. Underwood, *Boerhaave's men at Leyden and after* (Edinburgh: 1977).
[6] R. G. W. Anderson, 'Chymie to Chemistry at Edinburgh', *Royal Society of Chemistry Historical Group occasional papers*, **2** (2000), 1-28. The chemical aspects of Edinburgh's pharmacological scene are specifically treated in A. H. Maehle's *Drugs on trial* (Amsterdam: 1999).
[7] John Walker, *Systema fossilium*, Bound MS, Glasgow University Library (subsequently GUL) GB 247, MS Gen 1061 (1795 Watermark), f. 2. The introduction to this manuscript (which contains the above quotation), was republished over twenty years

This quotation shows that Walker's first taste of mineralogy was inspired by the natural philosophy course taught by Robert Steuart (1675-1747) in 1746.[8] This led him to read Robert Boyle's collected works (which included his treatise on gems),[9] John Woodward's *An Attempt towards a Natural History of Fossils of England,*[10] John Becher's *Physica Subterranea,*[11] Georg Ernst Stahl's *Philosophical Principles of Universal Chemistry,*[12] and Herman Boehaave's *Elements of Chemistry.*[13] Save for Woodward, all of these books were written by chemists. Having read these sources, Walker then attended the lectures of Andrew Plummer (d. 1756), the professor of chemistry in the Medical School. In addition to attending Plummer's lectures, it is quite possible that he also attended the *materia medica* course of Charles Alston (1683-1760).[14] Yet, aside from teaching Walker the basics of chemistry and natural philosophy, there is no convincing evidence that Plummer, Alston or Steuart had any significant impact on his early mineralogy.

Based on Walker's comments in his *Systema Fossilium* and on several other extant manuscripts from early in his career (to be discussed in the next section), it can be seen that his initial conception of mineralogy was shaped by what he read in the books written by Boyle, Woodward, Becher, Stahl and, to an extent, Boerhaave. However, the mineralogical classification promoted by these chemists/mineralogists was inconsistent. Since chemical nomenclature and vocabulary were not standardised until the end of the eighteenth century,[15] each of the authors above had a slightly different approach to mineralogy. For instance, Stahl based his system on chemical characters, while Woodward only used chemistry when physical characters were not enough. To make matters even more confusing, there were three different approaches to chemical classification being employed in these works: (1)

later as '*Notice of Mineralogical Journeys, and of a Mineralogical System*, by the late Rev. Dr. John Walker, Professor of Natural History in the University of Edinburgh', *Edinburgh philosophical journal*, 6 (1822), 88-95.

[8] This is the same Robert Steuart (also spelled Stewart) who taught David Hume and who founded 'The Physiological Library'. See M. Barfoot, 'Hume and the culture of science in the early 18th century', in *Studies in the philosophy of the Scottish Enlightenment*, M. A. Stewart (ed), (Oxford: 1990), 151-190.

[9] R. Boyle, *The philosophical works of the Honourable Robert Boyle esq.*, 2nd edn, Peter Shaw (ed), (London: 1738). Also see Boyle's *An essay about the origine & virtues of gems*... (London: 1672). Little research has been done on this book even though it enjoyed a wide circulation up until the end of the eighteenth century. See George White's foreward in Robert Boyle, *An essay about the origine and virtues of gems* (New York: 1972). For a brief treatment of this essay, see J. H. Brooke and G. N. Cantor, *Reconstructing Nature* (Edinburgh: 2000), 324.

[10] J. Woodward, *An attempt towards a natural history of the fossils of England, in a catalogue of the English fossils in the collection of J. Woodward, M.D.* (London: 1728-29).

[11] J. J. Beccher, *Physica subterranea: Profundam subterraneorum genesin, e principiis hucusque ignotis, ostendens... et specimen Beccharianium, fundamentorum documentorum, experimentorum, subjunxit Georg Ernestus Stahl*, (Lipsiæ, MDCCXXXIIX).

[12] G. Stahl, *Philosophical principles of universal chemistry: or, the foundation of a scientifical manner of inquiring into and preparing the natural and artificial bodies for uses of life*, Peter Shaw (trans), (London: 1730).

[13] Herman Boerhaave, *Elements of chemistry*, Timothy Dallowe (trans), (London: 1735).

[14] There are four of Alston's books listed in the 1804 posthumous catalogue of Walker's library: C. Elliot, *A catalogue of the books in natural history with a few others, which belonged to the late Rev. Dr. Walker, Professor of Natural History in the University of Edinburgh* (Edinburgh: 1804). Edinburgh University Special Collections (subsequently EUL) La.III.352/6. See Nos. 61, 58, 66, 220, 562.

[15] M. P. Crosland, *Historical studies in the language of chemistry* (London: 1962).

Aristotelian Elements (earth, water, fire and air), (2) Paracelsian *Tria Prima* (sulphur, mercury and salts) and (3) the five principle system (salts, inflammables, water, earths, and metals). Despite these different forms of chemistry, the authors listed above do agree on the general assumption that the concept of an 'earth' is central to any credible mineralogical arrangement.

During Walker's student years, there were generally two different conceptions of the word 'earth' (or *terra*). The first referred to the matter traditionally associated with the word 'soil'. I shall use the lower case form of 'earth' to connote this meaning. The second conception of earth was more philosophical. It referred to the one of four primary substances that made up all rocks and stones. I shall use an uppercase term—'Primary Earth(s)—to represent this definition.[16] (Likewise, I shall use the capitalised version of 'Salt' to connote bodies that 'are sapid, miscible with water, and not inflammable').[17] The idea that one Primary Earth could form the base of all minerals appealed to many mineralogists during the seventeenth and eighteenth centuries. Its intellectual lineage stretched back to Platonic 'forms' and the four Aristotelian elements. During the sixteenth century, chemists held that all matter was somehow born from a Universal Acid and it was this concept that was eventually transformed into the eighteenth century's idea of a 'universal' Primary Earth.[18]

Of the six authors above, only Becher and Stahl place a strong emphasis on the role played by Primary Earths in the classification of minerals. The others are either sceptical or unclear on the matter. For instance, Boyle, in his works on earths, minerals and metals, was more concerned with ascertaining practical applications. To achieve this goal, he looked at both physical and chemical characters. Yet, even though he was a chemist, he doubted the existence of a Primary Earth:

> *Hence we may reasonably doubt, whether the assertors of elementary earth can shew us any native substance deserving of that name; and, also whether what remains, after chymical analysis, tho' it has all the qualities, judg'd sufficient to denominate a portion of matter earth, may not yet be either a compounded body, or endowed with the qualities which belong not to simple earth.*[19]

[16] D. Oldroyd treats these two different definitions of earth in 'Some Phlogistic Mineralogical Schemes, Illustrative of the Evolution of the Concept of 'Earth' in the 17th and 18th Centuries', *AS*, **31** (1974), 269-306.
[17] This definition was offered countless times in William Cullen's lectures and was even used by W. Withering in his translation of T. Bergman's *Outlines of Mineralogy* (Birmingham: 1783), § 20. See Cullen's discussion of Salts in L. Dobbin, 'A Cullen Manuscript of 1753,' *AS*, **1** (1936), 138-156.
[18] N. E. Emerton masterfully traces this intellectual lineage from Plato to the eighteenth century in, *The scientific reinterpretation of form* (London: 1984). The role of Earths in eighteenth century chemistry is treated in A. Duncan, *Laws and order in eighteenth-century chemistry* (Oxford: 1996), see esp. 159-168.
[19] Boyle (1738),143.

Woodward shared Boyle's pragmatic view. He concentrated solely on physical characteristics, that is, the 'Nature', 'Properties' and 'Phenomena' of minerals.[20] For every fossil, wherever possible, he observed its placement in the ground and 'the Bulk, the Form, the Texture, the Constitution, the Purity or Mixtures discernible in it.'[21] This being the case, his work offers a vague definition of what he means by the word 'earth'. For him, anything in the ground that was not a mineral or a metal received this title.[22] Likewise, Boerhaave was not interested in strictly defining this term in *Elements of Chemistry* (even if he was, his vacillation between Aristotelian, Paracelsian and five-principle chemistry would have muddled the definition anyway).

Woodward's and Boyle's emphasis upon physical characters proved to be very useful for Walker throughout his entire career. In fact, Woodward remained a reference work that Walker recommended to his students after he became Edinburgh Professor of Natural History in 1779. However, the prominent role played by Primary Earths in Walker's *Systema Fossilium* (completed in the mid 1790s) demonstrates that it was Becher and Stahl who laid the conceptual foundations for his chemical approach to the composition of rocks and stones. Becher held that there were three kinds of Earth: Vitrescible, Fatty and Mercurial.[23] Because he was not able to isolate completely each element of this *tria prima*, each remained a philosophical construct similar to a Platonic 'form.' The purest representation of Vitrescible Earth was associated with quartz and was characteristically dry. It was the primary ingredient of stones and minerals and imparted the qualities of fusibility, solidity and opacity.

By the time Walker started attending the University of Edinburgh, the five-principle system of chemistry had become quite influential in the Medical School. By the mid 1750s, Cullen included all of the Primary Earths under the term 'Earth Principle'.[24] In the years that immediately followed his time at the University of Edinburgh, Walker eventually decided that Vitriscible Earth was one of five Primary Earths associated with the Earth Principle. However, he never ceased to believe that it was the oldest of all the Primary Earths. Such a view slightly differed from

[20] Woodward (1728-29), x.
[21] *Ibid.*, x-xi.
[22] Woodward, however, does state that he believed that the composition of 'earth' remained relatively constant—even if it was moved about by a flood. J. Woodward, *An essay toward a natural history of the earth: and terrestrial bodies, especially minerals* (London: 1695), 220, 260-262.
[23] Beccher (1738), 49.
[24] A discussion of the how chemical 'principles' were used in mineralogy at this time can be found in D. R. Oldroyd's 'The Doctrine of Property-Conferring Principles in Chemistry: Origins and Antecedents', *Organon*, **12/13** (1976/77), 139-155. For the chemical processes used to analyse Primary Earths, see Oldroyd's 'Some Eighteenth Century Methods for the Chemical Analysis of Minerals', *JCE*, **50** (1973), 337-340.

Becher, who held that there was a foundational Primary Earth (Fatty Earth) which served as the base for all Earths and which conferred colour, taste and odour.[25] Like Becher, Stahl maintained the *tria prima* stance, and it was this conception of 'Earths' that was given the title 'primitive Earths' in Peter Shaw's widely read English translation of Stahl's *Philosophical Principles of Universal Chemistry*.[26] Because Stahl accepted many of Becher's chemical definitions,[27] their works are sometimes collectively called the Becher-Stahl School.[28] The influence of this school upon seventeenth and eighteenth century chemical mineralogists was quite significant.[29] In Edinburgh, its influence was felt in the articles printed in *Essays and Observations, Physical and Literary*, the principal journal of the Medical School and Edinburgh Philosophical Society from the 1750s until the 1770s. The Becher-Stahl School also influenced Cullen, Walker's chief mentor. Even after its chemistry was eclipsed at the end of the century, Walker still referred to the phlogiston theory in his geology and mineralogy lectures.[30] He never ceased to maintain that, 'The first persons among the moderns that aimed at the proper method of arrangement in the fossil kingdom were Becher and Stahl.'[31]

William Cullen and Primary Earths

After Walker finished attending the University of Edinburgh in 1749, he was ordained into the Church of Scotland. Around 1753 or 1754, he made two marl and (mineral) manure collections and submitted them to the Edinburgh Philosophical Society. He was awarded medals for both collections and it was this recognition that first made him known to William Cullen and possibly to Lord Kames. Although Cullen lived in Glasgow until 1755, he had been a member of the Society since 1749 and was 'more and more attached to Mineralogy, which was at that Time indeed, his own favourite Pursuit.'[32] Walker and Cullen struck up a friendship and Walker began to study chemistry with him soon thereafter. A close bond formed between them and Walker's writings from the 1750s demonstrate that he based most of his chemistry upon Cullen's teachings. Influenced by the Becher-Stahl School,

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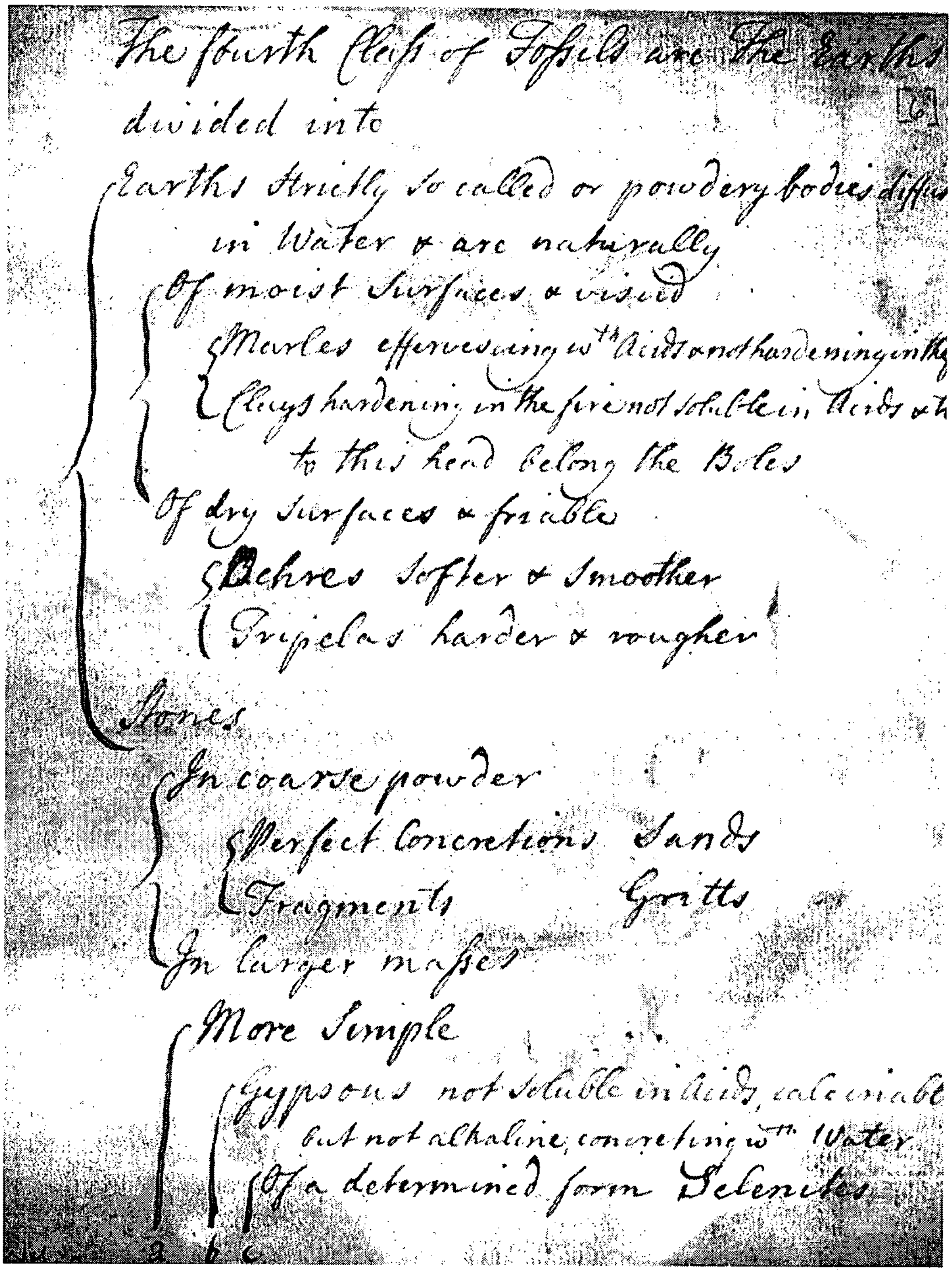
[25] Oldroyd (1974), 269-305.
[26] Stahl, (1730), 13. At this time, 'Primitive Earth' was used interchangeably with 'Primary Earth'.
[27] D. R. Oldroyd examines some of the philosophical aspects of Stahl's chemistry in 'An Examination of G. E. Stahl's *Philosophical Principles of Universal Chemistry*', *Ambix*, **20** (1973), 36-52.
[28] R. Laudan, *From mineralogy to geology: The foundations of a science, 1650-1830* (London: 1987), 47-69.
[29] Emerton (1984), 225-226.
[30] For instance, his 1780s and 1790s geology lectures, Walker cites Becher's *Chymisches Laboratorium* (Frankfurt: 1680); *Natur-Kündigung der metallen* (Frankfurt: 1679); *Parnassi illustrati...mineralogia* (Ulm: 1663); *Physica subterraneae* (Frankfurt, 1703). See Walker (1966), 271.
[31] Walker (1966), 'Mineralogy Lecture', 224-225. This edition of Walker's work only includes his introductory lecture on mineralogy. The rest of the manuscript notes taken by students during his mineralogy lectures are housed in EUL.
[32] Walker, (c.1795), f. 4.

Boerhaave and Pierre Joseph Macquer,[33] Cullen employed the five-principle chemical system. During the 1750s, Cullen spent a great deal of time trying to develop a systematic arrangement for Salts. He also performed experiments that allowed him to aver that the Earth Principle was 'not soluble in water, not inflammable, of a dry & solid consistence, either not fusible in the fire or if fusible concreting again in the form of glass.'[34] After reading Johann Heinrich Pott's *Lithogéonosie*[35] sometime during the mid 1750s, Cullen became convinced that there were four genera of Primary Earths:[36]

1. Vitrescible
2. Calcareous
3. Argillaceous
4. Talky

In the Cullen Collection housed in the University of Glasgow Special Collections Department, there are numerous copies of Cullen's manuscript notes that he used to give his lectures during the 1750s. Though illegible in several cases, these clearly define his conception of the four Primary Earths (Plate 3.I). He held that *Vitrescible Earths* quickly changed to glass, became readily transparent with the application of fire, struck fire with steel, were little altered by calcinations and were not dissolved by acids. Because of their glass-like transparency, he often referred to them as 'crystalline'. Within this genus he included gems, flint, calculi, sands, quartz and fusible spar (probably feldspar).[37] *Calcarious Earth* could either be burnt to quicklime or dissolved with effervescence in acid menstruums. It included marble, limestone, chalk, spars, stalactites, shells, marls, magnesia alba, aluminous earth, quicklime and earths that contained animal and vegetable matter.[38] *Argillaceous Earth* on account of its 'viscidity & fineness' was not dissolvable by acids, could be turned upon a lathe and became harder and more compact when

[33] Pierre Joseph Macquer, *Élémens de chymie théorique* (Paris: 1749); *Elémens de chymie-pratique. Contenant la description des Opérations Fondamentales de la chymie, avec des explications & des remarques sur chaque opération* (Paris: 1751).
[34] W. Cullen, 'Misc. Lectures Notes, Re: Earths by William Cullen', GUL MS Cullen 795, f. 1. Also treated in ff. 2-8. Compare to Black's 1767/8 definition: '*Terrea sunt solida, sapida, nec aqua pura Simplici Solubilia nec Inflammabilia & nunquam fusibilia quin in Vitrum Abuent.*' T. Cochrane, *Notes from Doctor Black's Lectures on Chemistry 1767/8*, Douglas McKie (ed), (Wilmslow: 1966), 27.
[35] GUL MS Cullen op. cit. (35), f. 6. J. H. Pott, *Lithogéognosie ou examen chimique des pierres et des terres en général: et du talc, de la topaze & de la statite en particulier avec une dissertation sur le feu et sur la lumière* (Paris: 1753). The German edition first appeared in 1745. Pott's Earths and their relation to mineralogy are discussed in T. M. Porter, 'The Promotion of Mining and the Advancement of Science: The Chemical Revolution of Mineralogy', *AS*, **38** (1981), 543-570. See esp. pages 556-558.
[36] Cullen used the term 'Primitive Earths'. These are clearly stated in the 'Pharmaceuticæ Cullini' section of Black's 1767/8 chemistry lecture notes. Cochrane (1966), 26-28.
[37] For more on Cullen's chemical conception of Vitrescible Earths, see 'Of Vitrescent Earths and Vitrifications... by Cullen', GUL MS Cullen 268/8.
[38] The following definition of the four Earths are taken from William Cullen, 'A Chemical Examination of Common Simple Stones & Earths... by William Cullen with Notes [Incomplete] on Alkali Earths and the Earth's Structure', GUL MS Cullen 264, f. 1.


The fourth Class of Fossils are the Earths
divided into [6]
Earths strictly so called or powdery bodies diffus
in Water & are naturally
Of moist Surfaces & viscid
Marles effervescing wth Acids and hardening in the
Clays hardening in the fire not soluble in Acids & th
to this head belong the Boles
Of dry Surfaces & friable
Ochres softer & smoother
Tripelas harder & rougher
Stones
In coarse powder
Perfect Concretions Sands
Fragments Gritts
In larger masses
More Simple
Gypsous not soluble in Acids, calcinable
but not alkaline, concreting wth Water
Of a determined form Selenites
a b c

Cullen's Glasgow Lectures on Minerals (early 1750s)
EUL MS Cullen 264 f. 6

Because acids and alkalis were often derived from local 'fossils', minerals were an essential part of Cullen's chemistry lectures.

exposed to fire. This genus contained white clay, coloured clays, steatites and ferruginea.[39] *Talky Earth* was less well-defined because Cullen could not decide whether or not it included *Gypseous Earth.* This fluctuating genus contained selenicks and gypsum. Upon being burned, these fossils 'changed into a gypsum or Such a kind of Quicklime as is dissolved in kinds of Acids & is the longest resisting vitrification.'[40] Based on Cullen's observations, Joseph Black would later decide that Talky Earth and Gypseous Earth both formed their own separate class.

Aside from a few physical qualities like transparency and malleability, Cullen's prevailing method for determining Primary Earths was chemical. More specifically, his tests employed 'Fire' and 'Chemical Menstrua'. Cullen's usage of 'Fire' generally meant 'heat'. Or, as he stated, 'the presence of Fire' can vulgarly be judged by the presence of 'Heat & Light'.[41] 'Chemical Menstrua' referred to humid forms of analysis (aqueous solutions) that were governed by the Salt Principle (which Cullen also called the Doctrine of Salts).[42] During his time as Walker's teacher, his use of heat had convinced him that all Primary Earths might be reduced to 'a transparent vitrious body'. Echoing the Becher-Stahl School, Cullen felt that this suggested the 'possibility of the universal clarification of our opaque terrene Globe.'[43] This excited him because such a Primary (Vitrescible) Earth could serve as the base for a standardised mineralogical system. Yet, Cullen could not actively argue for the explicit existence of such a Primary Earth because the only way to reduce Calcareous, Gypseous and Argillaceous Earths into a vitrescible state was by adding saline mixtures.[44] The presence of these Salts made it hard to determine whether or not the original Earth under examination was truly vitrefiable. Even so, Cullen's acceptance of the Primary Earths allowed him to hold that all rocks were 'nothing else but Earths baked firmly together'.[45] As such, they could be reduced back to their constituent Earths if pulverised. For this reason, he was more concerned with chemical experiments that tested for the presence of Primary Earths.

In addition to identifying a stone's Primary Earths, Cullen's chemistry lectures also treated another important mineralogical topic: earth. He defined this as 'powdery bodies diffusible in Water.'[46] With this definition, it seems that Cullen

[39] Cullen, (GUL MS Cullen 264), f. 1.
[40] Cullen, (GUL MS Cullen 795). 1 and f. 5.
[41] *Ibid.*, f. 5.
[42] Cullen's saline analysis is discussed in several places in A. L. Donovan's *Philosophical Chemistry* (Edinburgh, 1975).
[43] Cullen (GUL MS Cullen 795), f. 1.
[44] Saline experimentation was arguably a leading form of humid analysis in both Scotland and France during the early to mid eighteenth century. For the French scene, see F. L. Holmes, 'Analysis by Fire and Solvent Extractions: The Metamorphosis of a Tradition', *Isis*, **62** (1971), 129-148.
[45] Cullen (GUL MS Cullen 795), f. 1.
[46] Cullen (GUL MS 264), f. 7

was trying to portray earth as a make-shift species that fell between Primary Earths and Salts. However, such a broad definition was not without its problems and Cullen spent a good deal of time trying to iron out the conceptual wrinkles. It seems that Walker was involved in this process because he published an article in the 1757 edition of the *Philosophical Transactions* which addressed the shared characters of saline and terrene mineral water solutions.[47] In general, Cullen held that there were two types of earth. The first was 'of moist surfaces & viscid'. These consisted of marls and of clays. He sometimes placed stipulations on these substances. He held that marls should effervesce in acid and should not harden in fire. Clays should harden in fire and be soluble in acids. The second type of earth was 'of dry surfaces and friable'. These consisted of ochres and 'tripelas'.[48] He sometimes stipulated that the ochres should be 'soft and smooth' and the tripelas should be 'hard and rough'.

Cullen's interest did not stop at Primary Earths and earths. He even offered a basic classification system for stones. He held that they consisted of two types: Powdery and Solid. Powdery Stones, or rather those 'In coarse powder',[49] consisted of sand, grit and earth fragments. Solid Stones, or, those 'In larger Masses',[50] consisted of two general divisions: Simple and Structured. Since Cullen thought that stones were composed of a mixture of Primary Earths and earths, his classifications are quite rough and sometimes overlap. Simple Stones included gypseous, freestone, limestone, rockstone and (curiously) granite. The description he offers for 'Structured' stones in his manuscript notes is vague and seems to be directed at the concreted matter surrounding rocks. He offers four types: Determined, Milky, Coloured and Clear. Sprinkled throughout his entire classification of stones are also chemical characters which are usually determined by experiments involving acid. Thus, Cullen oscillates between physical and chemical characters for this classification. The physical characters that he particularly liked were softness, hardness, smoothness, colour and stratigraphical alignment.

In addition to mineralogy, Cullen's chemistry was relevant to both medicine and natural history. Such a link was not new in Britain. For instance, in addition to emphasising the value of applying chemistry to all the kingdoms of nature, Boyle's comments on the actual practice of natural history served as a guide for many

[47] J. Walker, 'An Account of a new medicinal Well, lately discovered near *Moffat*, in *Annandale*, in the County of *Dumfries*. By Mr. *John Walker*, of *Borgue*-House, near *Kirkcudbright*, in Scotland', *Philosophical Transactions of the Royal Society of London* (1757), 50, 117-147. This chemical content of this article is treated in Eddy (2001a).
[48] Tripela is Cullen's word for 'tripoli', which is 'A fine earth used as a polishing-powder, consisting mainly of decomposed siliceous matter, esp. that formed of the shells of diatoms; called also infusorial earth or rotten-stone', *OED*.
[49] Cullen (GUL MS Cullen 264), f. 7.
[50] *Ibid.*, f. 7.

naturalists.[51] Likewise, Cullen's lectures make the link between natural history and chemistry quite clear:

> *Natural History is what acquaints with the native place[,] & the Sev^l appearances of all the Subjects of Art or Commerce[,] it must appear to deserve particular attention & that it is Chemistry that teaches the various manufacture of these for the purposes of Life[.] Both together may be considered as important to Society[.] They are necessarily connected together[.] The chemist will often blunder if He cannot distinguish Natural Productions & at the same time The Naturalist will not be able properly to distinguish the Sev^l Similar productions of Nature without the Assistance of Chemical Exp^{ts} [.]* [52]

Based on this rationale, Cullen kept his own mineralogical collection, which Walker purchased for the Edinburgh Natural History Museum in the 1790s.[53] Cullen also encouraged his other students to do the same, as can be seen by the fact that Black was also interested in collecting minerals.[54] Cullen's above lecture on this topic goes on to direct his students to examine minerals because: 'The Earth of every Country contains in its Bowels a variety of Valuable Matters that are neglected & undiscerned[.] Arts are often at a loss for matter[ial]s & we often import[.] This Country has been so little examined that probably many treasures are reserved to the discovery of Skilfull persons[.]' He then proceeds to give a long list of minerals worth investigating in Scotland. Walker took this list quite seriously because he made it a point to examine many of its items during the next two decades.[55] This allowed him to acquire the specimens that eventually become part of the University of Edinburgh's Natural History Museum.[56] In this manner, chemistry and mineralogy were mutually dependant. Chemistry provided characters by which rocks could be classified – first into genera based on Primary Earths and then into classes. These characters were not only used for arranging minerals. They were also employed in the making of pharmaceuticals and in the purification of mineral ores. The latter was linked to mining and could therefore be used to obtain patronage. This is why Walker's contemporary Black analysed box after box of minerals sent to him by

[51] R. Boyle, *General heads for the natural history of a country great or small* (London: 1692). For an example of his application of chemistry to natural history, see R. Boyle, *Short memoirs for the natural experimental history of mineral water* (London: 1684).
[52] W. Cullen, 'Fragments of a Lecture by Cullen Concluding and Summarising the First Part of the Course; Natural History and Its Productions', GUL MS Cullen 258, f. 2 – f. 3.
[53] Walker (c. 1795), f. 16.
[54] R. G. W. Anderson, *The Playfair collection and the teaching of chemistry at the University of Edinburgh 1713-1858* (Edinburgh: 1978), 58.
[55] Walker went on to write similar lists for his students: 'A Memorandum Given by Dr. Walker, Professor of Natural History, Edinburgh, to a Young Gentleman Going to India, with Some Additions', *The bee*, **17** (1793), 330-333. Likewise, Robert Jameson, Walker's student and successor, went on to do the same: 'Literary and Scientific Intelligence', *The Edinburgh magazine and literary miscellany; A new series of the scots magazine*, 1 (1817), 367-369.
[56] For Walker's later involvement with the University of Edinburgh Natural History Museum, see C. D. Waterston, *Collections in context: The museum of the Royal Society of Edinburgh and the inception of a National Museum of Scotland* (Edinburgh: 1997), 1-41.

Lord Hopetoun and other naturalists during the 1770s.[57] In addition to analysing mineral ores, chemistry was incorporated into the larger utilitarian enterprise of agricultural improvement. This is why the Philosophical Society was interested in Walker's 1753/4 marl collections. Following this pattern, Walker continued to promote the interaction of chemistry and natural history throughout his career[58] and like Cullen, gave a public lecture on the topic in 1788.[59]

II. Chemistry and Classification

Walker's Early Attempts at Arrangement

Cullen's combination of chemistry and natural history had a profound effect on Walker. The first printed indication of this effect was in his 1757 *Philosophical Transactions* article on mineral water.[60] Walker maintained his interest in chemistry over the next ten years as he toured Scotland. As these travels were extensive, they will be treated in the next section. The main goal of the present section is to detail his nascent classification system. The manuscript sources on this topic for the period between 1757 and 1766 are few. Of those that are extant, there is no clear indication as to which single mineralogical classification influenced Walker's early investigations. Even though the 1761 index of his library shows what he was reading,[61] it does not indicate his personal definition of a Primary Earth, nor does it specifically identify his classificatory preference. His index also does not list several books that were published before 1761, but that proved to be quite influential to Walker's mineralogy in the mid 1760s—a good example being Linnaeus's *Systema Naturæ*. A 1771 report that he compiled for his 1764 Hebrides and Highlands tour offers a similarly murky picture. Since it is quite likely that he interpolated several authors into the text, it is difficult to determine which books he was actually using when he took his 1764 tour.[62]

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[57] EUL MS Black 873-5. John Hope [2nd Earl of Hopetoun] to Joseph Black, 19 May 1770, ff. 28-30. John Hope to Joseph Black, 9 June 1770, f. 31. A. J. Alexander [from Bracelot, Grenada] to Joseph Black, 31 April 1773, ff. 58-62. John Graham [from Cumberland] to Joseph Black, n.d., ff. 76-77.

[58] As Professor of Natural History, Walker was the academic patron (along with Joseph Black) of the Natural History Society of Edinburgh organised by students during the 1780s and during this time, chemistry played a prominent role in the papers that were given. D. E. Allen, 'James Edward Smith and the Natural History Society of Edinburgh', *JSBSH*, **8** (1978), 483-93. See especially page 489.

[59] John Walker, 'Public Lecture, Anno 1788, on the Utility and Progress of Natural History and Manner of Philosophising', *Essays on natural history and rural economy*, Charles Stewart (ed), (Edinburgh: 1808), 323-347.

[60] Walker, (1757).

[61] John Walker, *Index librorium (1761)*, Bound MS, EUL, Dc.2.38. This not only lists the books that were in Walker's possession, it also offers a methodological commentary of some of them.

[62] Originally compiled into a report and named the *Kings MS*, this work was published in 1980: *The Rev. Dr. John Walker's report on the Hebrides of 1764 and 1771*, Margaret M. McKay (ed), (Edinburgh: 1980). Augmentations of the sections on Jura and Iona were eventually published in Walker's *Essays* (1808), as 'History of the Island of Icolumbkil', 111-199, and 'History of the Island of Jura', 219-281.

The first clear indication as to which classification system was guiding his initial mineralogical activity is found in a notebook of natural history commonplaces entitled *Adversaria*.[63] Kept from 1766 to around 1772, it is a collection of aphorisms, observations and thoughts drawn from personal observation, books, articles and conversations.[64] Much of this information would eventually be included in the natural history lectures and articles that he wrote after he became a professor in 1779. Since the first entry is numbered '300', it is likely that *Adversaria* is the only remaining example of a set of several notebooks. Even though it contains observations on all three kingdoms of nature, it focuses chiefly upon mineralogy and botany. The mineralogical entries are helpful for two reasons. First, they include the half-dozen or so authors who most influenced Walker at this time (sometimes specific books and page numbers are cited). Second, there are several lists of minerals that were either collected by him or by other naturalists. In entry 335, he lists general directions on how a beginner might group newly collected Fossils:

α. Gems. Crystals. Agates. Pebbles. Jaspers. Granites. Porphyries. Free stone. Whetstone. Touchstone.

β. Marbles. Limestone. Flints. Spars. Chalk. Alabaster. Stalactites. Petrifactions.

γ. Talc. Slate. Asbestos.

δ. Salts. Vitriols. Selenites.

ε. Amber. Ambergrease. Bitumens. Coal. Pyrites. Sulphurs. Arsenic. Pumice. Lava.

ζ. Loams. Marls. Clays. Sands. Boles. Ochres.

η. Ores of all the Metals & semi-metals.

θ. Petrified Wood, Plants, leaves, Fruits, Shells, Bones.

ι. Figured fossils, as Entrochi, Belemnites, Asteno, Cornua Ammonites. Glossopetra.

κ. Superficial Delineations of Herbs, Trees, Ruins &tc. upon Stones.[65]

At present it is hard to know if Walker based this list on something that he read (either in a book or in a letter) or if it was of his own creation. No matter where he got it, the list demonstrates the direct influence of Cullen and chemical mineralogy. Not only is it based on the five principle system propounded by Cullen and many of his colleagues in Edinburgh's Medical School (Salts, Inflammables, Metals, Earths and Water),[66] its first four categories are directly based on the fourfold division of Primary Earths (vitrescible, calcareous, argillaceous and talcy) that Cullen took from Pott. The α group contains stones that are indurated and composed

[63] John Walker, *Adversaria* (1766-72), Bound MS, GUL MS Murray 27.
[64] *Adversaria's* semi-aphoristic style in parts is similar to the approach taken by Linnaeus in *Philosophica botanica* (Stockholm: 1751). Joseph Black was also interested in such a type of personal notation. See Thomas Thomson, *The History of Chemistry Vol. I* (London: 1830), 315.
[65] Walker, (1766-72), f. 157. The Greek characters are Walker's. The 'Asteno' fossil in the ι class might possibly be 'Asteria'.

of a high percentage of vitrescible Earth. The β group is generally made of calcareous Earth and is semi-hard. The γ group is soft and contains talcy Earth. The fossils in the ζ group are composed of various ingredients characteristic of argillaceous Earth. Walker used Salts, Inflammables and Metals to form his next categories. The δ group contains Salts or minerals like fluors that had qualities that Walker would have understood to be saline.[67] Those placed in the ε group are either inflammable themselves or are a naturally occurring product of inflammables. Finally, the η group was based on Metals.

Once Walker had used chemical principles to group metals and minerals, he then grouped the remains of animals or plants found in the ground. Here he moves beyond the realm of rocks and stones. Since the nature of these objects limited his ability to use chemical characters, he relies more on the natural characters[68] to group such organic 'Productions' (groups θ, ι, κ). However, despite such a naturally based classification, the chemical properties of these productions were still a topic addressed by eighteenth century chemists. Joseph Black devoted a whole section to the productions of animals and vegetables in his 1767/8 lectures[69] and many of the chemical mineralogists mentioned in Walker's *Adversaria* and his 1761 library index included similar categories.[70] Like Black, all of Walker's early classifications were based upon the chemistry of the day. The only chemical element that is not included in their classifications is Water. Technically, however, it was not a fossil and this is probably why it is omitted. Walker did believe that Water was important for mineral studies—as can be seen in his 1757 *Philosophical Transactions* article on Hartfell Spa.[71]

Figure I. Walker's Rudimentary Mineralogical Classification, late 1760s.

Earth	**Salt**	**Inflammables**
α group (vitrescible)	δ group	ε group
β group (calcareous)		
γ group (talcy)	**Metals**	**Organic**
ζ group (argillaceous)	η group	θ, ι, κ groups

[66] This was also system used by Black (Cullen's former student) during the 1760s, the only difference was that he added the sixth category of 'Airs'. See Cochrane, (1966).
[67] Elsewhere in *Adversaria*, Walker held that fluors were ''compound Bodies, consisting of a Salt and an Earth.' And that therefore, they should be strictly ranked among the Salia, having no Title [title] to the Character of simple primitive Earths, which have been given them.' Walker (1766-72), f. 145.
[68] That is, those that are externally observable. This type of character will be discussed in more detail in the next chapter.
[69] Cochrane (1966), 173-190.
[70] For instance, see, the 'petrifcation' classes in J. G. Wallerius, *Minéralogie, ou description générale des substances du regne minéral.* (Paris : 1753) and in F. A. Cartheusar, *Elementa mineralogie* (Frankfurt: 1755).

Systematic Mineralogy Sources

Of the half dozen or so authors mentioned in *Adversaria*, only Emanuel Mendes Da Costa's *A Natural History of Fossils*[72] and Linnaeus's *Systema Naturæ* receive a notable amount of attention. Even though each of them based their system on physical characters, both used chemistry at some point in their classification. However, their systems were different. Da Costa took issue with Linnaeus's method[73] and had created his own classification which ran in the following order: *series*, *chapter*, *genus*, *section* and *member*. As he did not finish his system, there are only two series: Earths and Stones. The chapter, genus and section are formed on physical features (colour, texture, etc.) and the members are differentiated based on their reactions to acids and alkalis. Likewise, Linnaeus resorted to chemistry as a final option to be used after physical characters were exhausted: 'The student has three modes of investigating this [Mineral] Kingdom: *Physical*, which descends through the obscure generation of minerals: *Natural*, which considers their superficial and visible structure: *Chemical*, which ascend through their destructive analysis.'[74] For the last, Linnaeus employed fire and acids. He also used several other characters that fell within the realm of eighteenth century humid analysis: concretion, cementation, calcination, putrefaction and crystallisation.[75]

Walker's early classification clearly demonstrates that he did not follow the naturally based approach of Linnaeus and Da Costa. His many references to these authors show his life-long proclivity to cite works that were ordered by taxonomies (or even an epistemology) that he himself did not support. He had no problem with extracting examples from one book and then inserting them into a system (usually his own) that seemed more reasonable. He began this practice early in his career with his use of Becher, Stahl and Woodward and he continued it in his geology lectures where he cites theorists like Buffon and Maupertuis (a point that will be further explored in the Chapter 4). This process of extracting and inserting natural history commonplaces was common during the Enlightenment. In mineralogy's case, the sea of sources produced a canon of works from which examples were most often

[71] Walker was fascinated with mineral water for his entire career. In addition to his 1757 article and the mineral water works in his 1761 *Index*, there are several manuscript notes from the 1780s that address the topic. See EUL Dc.1.58 f.2, f.40, and ff. 90-92.

[72] E. M. da Costa, *A natural history of fossils* (London: 1757).

[73] G. S. Rousseau and D. Haycock, 'The Jew of Crane Court: Emanuel Mendes da Costa (1717-1791) Natural History and Natural Excess', *HS*, **38** (2000), 139-142.

[74] C. Linné, *A general system of nature, through the three grand kingdoms of animals, vegetables, and minerals: Systematically divided into their several classes, orders, genera, species, and varieties – Vol. VII*, William Turton (trans), (Swansea: 1804), 9. Also see, C. Linné, *Systema naturæ per regnatria naturæ, secundum classes, ordines, genera, species, cum characteribus & differentiis. tomus III. Cum privilegio siæ riæ mitis seciæ, & electoris Saxon* (Homiæ: 1768), 11.

[75] See Linné (1804), 3-9; Linné (1768), 3-11.

taken.[76] Da Costa, Linnaeus,[77] John Hill and Woodward were the standard works cited by British mineralogists.[78] However, the difference between citing them and actually agreeing with them was sometimes quite vast.

As Walker's work demonstrates, it was quite common to praise these canonical authors in one sentence and then criticise them in the next. In general, the preface of almost every systematic mineralogy book was full of attacks upon the shortcomings of previous authors. Da Costa's *History* was no exception: 'I have attentively examined the Woodwardian and Wallerian systems, and, finding them defective, have presumed to form a new one from the principles of both.'[79] Ironically, Da Costa was criticised in the same manner by later mineralogists, one of them being Walker himself: 'Mr. Da Costa has from Germany the same red micaceous Fossile, which is found at Dalswinton. He considers it as an Ore of Iron, as Linnaeus likewise does, tho' probably I think with some impropriety. It is the Ferrum intractable nitens micaceum. Lin.[naeus].'[80] Sometimes these criticisms became rather pointed and this caused tempers to flare. However, in Walker's case, his fruitful correspondence with Da Costa during the 1760s suggests that he took issue with the system and not with the man.

Walker's disagreement with Da Costa and Linnaeus over the classification of the ferrous/micaceous mineral in the quotation above is significant because it touches on two important issues presented by *Adversaria*. First, it demonstrates Walker's emerging proclivity to use chemical analysis as a means for disagreeing with well-known mineralogical authorities. No doubt, his contention with Da Costa and Linnaeus on this point was informed by the 'iron principle' experiments that he performed on Hartfell Spa in 1757. Second, in the course of his mineralogical observations, Walker cites Johan Gottschalk Wallerius (1709-1785), the eminent professor of chemistry at the University of Uppsala (1750-1767).[81] During the mid eighteenth century, Wallerius wrote about a number of chemically related disciplines, but his most influential mineralogical work in Britain was *Mineralogie, ou Description Générale des Substances du Règne Minéral* (1747).[82] Citing this work to clarify the classification of *ferrum intractable nitens micaceum*, Walker

[76] R. Porter, *The making of geology* (Cambridge: 1977), 112-118.
[77] Linnaeus' conceptual framework was hard for most chemical mineralogists to escape, even in his native Sweden. See H. Fors, 'Chemistry and the Mining Industry in Eighteenth-Century Sweden' (personal communication).
[78] Some of the others were J. Hill's *A general natural history: or, new and accurate descriptions of the animals, vegetables, and minerals of the different parts of the world* ... (London: 1748-52) and Woodward's *An attempt towards a natural history of the fossils of England; in a catalogue* (1728-29).
[79] Da Costa (1757), iv.
[80] Walker (1766-72), f. 152.
[81] J. R. Partington, *A History of Chemistry, Vol. III* (London: 1962), 169-172.

writes: 'Of this Species Wallerius has 2 Varieties.'[83] This reference to Wallerius is notable because it links Walker to Swedish chemical mineralogy at a very early date.

Not only does he make several references to Wallerius, Walker also mentions Wallerius's disciples Jacques-Christophe Valmont de Bomare (1731-1807) and Axel Fredrik Cronstedt (1722-1765). Bomare was then 'Démonstateur d'Histoire Naturelle, Membre de la Société Litteraire de Clermont-Ferrand, de l'Académie royal des Belles-Lettres de Caën, de l'Académie royale des Sciences, Belles-Lettres & Beaux-Arts de Rouen' and was the author of *Mineralogie, ou Nouvelle Exposition du Régne Minéral* (1762).[84] Cronstedt's work on mineralogy had been written in 1758, but had gained a wider audience when it was translated into German during 1760.[85] The mineralogies of Wallerius, Bomare and Cronstedt all based their systems upon Primary Earths just like Walker, Cullen and Black. In fact, it was Cullen himself who had first introduced Walker to Cronstedt in 1764:

> *Not long before I set out [for the Hebrides], Dr. Cullen had received the first German Edition of Cronstedt's Essay, of which he was so fond, that he carried it for several Weeks in his Pocket. He translated to me the leading Characters of Cronstedt's new & peculiar Classes. He was particularly anxious about the Zeolite. And it was in consequence of this, that I first observed it, among the Basaltick Rocks at the Giants Causeway, though afterwards, in greater Plenty & Variety in many of the Islands.*'[86]

By 1766 Walker was discussing Cronstedt's chemical mineralogy with the German naturalist F. W. P. Fabricius.[87] In *Adversaria* Walker takes care to note Cronstedt's comments on Zeolite, particularly because of its relation to talc: 'He [Fabricius] says our whole Canna Fluor is not a Talc, but the Zeolite of Cronstedt, who has found it in the same Genus with the Lapis Lazuli, because both have this remarkable Property, that with Aqua fortis they dissolve into Gelly.'[88] Walker's connection to Swedish chemical mineralogy was even further solidified by the fact that Da Costa (Walker's primary mineral supplier in England) traded minerals with Wallerius and eventually

[82] The original was published in Swedish (Stockholm: 1747 and 1750). The French edition was based upon the German translation (Berlin: 1750).
[83] Walker (1766-72), 152.
[84] J.C. V. de Bomare, *Minéralogie, ou nouvelle exposition du règne minéral. Ouvrage dans lequel on a tâché de ranger dans l'ordre le plus natural les individus de regene, & où l'on expose leurs propriétés & usages méchaniques; avec un dictionnaire nomenclateur et des tables synoptiques* (Paris: 1762). Quotation taken from the frontispiece.
[85] Cronstedt's first chemical mineralogy system was published in Swedish as *Försök till mineralogie* (Stockholm: 1758), however it was its 1760 German translation that brought it to the attention of mineralogists in the German, French and English speaking countries. See Cronstedt's entry in the *DSB*; D. R. Oldroyd, 'A Note on the Status of A. F. Cronstedt's Simple Earths and his Analytical Methods', *Isis*, **65** (1974), 506-512; Porter (1981), 558-560. Interestingly, James Hutton also used Cronstedt's work. See J. Jones, 'The Geological Collection of James Hutton', *AS*, **41** (1984), 223-244, esp. 239.
[86] Walker (c. 1795), f. 7; Walker (1822), 90.
[87] Fabricius received his medical doctorate from the University of Edinburgh in 1767. His thesis was entitled: *Tentamen medicum inaugurale, de emetatrophia. Quod, annuente summo numine, ex auctoritate reverendi admodum viri, Gulielmi Robertson, S.S.T.P* (Edinburghi: 1767).
[88] Walker (1766-72), f. 212.

edited the first English edition of Cronstedt's *Mineralogy*.[89] Additionally, several of the minerals in Walker's collection came from Sweden and Norway. Thus, both directly and indirectly, Walker was able to remain informed on Scandinavian chemical mineralogy.[90]

III. Building a Collection

The Mineralogy of Travel

One of the distinguishing marks of the professors who lectured in Edinburgh's Medical School was that they understood the pedagogical effectiveness of passing around natural history specimens. Students were also encouraged to build their own collection of mineralogical and botanical simples and this contributed to an *in situ* form of naturalism that lasted well into the nineteenth century.[91] Apart from building curiosity collections, this seems to have been the leading motivation for collecting minerals in Scotland during the mid eighteenth century.[92] As Walker's biography demonstrates, one of the most common ways of locating useful minerals in Scotland was travel. During his student years, he first explored the Edinburgh area with his friends Edward and Alexander Wight. He visited quarries, collieries, the King's Park and the Firth of Forth's shoreline. Even though he mentions these and many of other trips in his *Systema Fossilium*, it is sometimes difficult to trace his exact steps because he visited several places more than once and because he did not leave behind any personal diaries. Even so, his trips can be divided into two over-arching categories: short and long tours. He used short tours to explore almost the entire mainland of Scotland. They could last from a few days to a few months. In his early travels (1753-1762), he explored areas in Mid and South Lothian, Tweeddale,[93]

[89] A. F. Cronstedt, *An Essay towards a system of mineralogy: by Axel Frederic Cronstedt. Translated from the original Swedish, with notes, by Gustav von Engestrom. To which is added, a treatise on the pocket-library, containing an easy method, used by the author, for trying mineral bodies, written by the translator. The whole revised and corrected, with some additional notes by Emanuel Mendes Da Costa* (London: 1770).

[90] It is worth noting here that Walker does not seem to have been influenced by Werner at any point in his career – even after his student Robert Jameson went to Saxony to study with him during the 1790s. This is most likely because Werner's classification was based on physical characters. See Scott's introduction in Walker (1966), xxiv-xxv, xxxvii; J. M. Sweet and C. D. Waterston, 'Robert Jameson's Approach to the Wernerian Theory of the Earth, 1796' *AS*, **23** (1967), 81-96, esp. 81-83. Walker also does not seem to have utilised crystallographic criteria.

[91] The practice of a physician traversing the woods and fields to find *materia medica* simples reaches back to Hippocrates. In 1683 the Scottish geographer Sir Robert Sibbald stated: 'As for the Practice of *Medicine*, *Hippocrates* hath abundantly proven, that a Physician must, who would practise alright, first know the place.' *An account of the scotish atlas, or the description of Scotland ancient and modern* (Edinburgh: 1683), 1-2. The link between local naturalism and *materia medica* in modern times has been treated by D. E. Allen in 'Walking the swards: medical education and the rise and spread of the botanical field class', in D. E. Allen (ed.), *Naturalists and society* (Aldershot: 2001), Part I. Also see Chapters I and II in his *The naturalist in Britain* (London: 1976).

[92] This seems to shed some light on Hugh Torrens's statement that: 'The question of how minerals were found in the first place, prior to their being uncovered and mined, has been strangely neglected', 'Some Thoughts on the Complex and Forgotten History of Mineral Exploration', *JOUGS*, **17** (1997), 1-12.

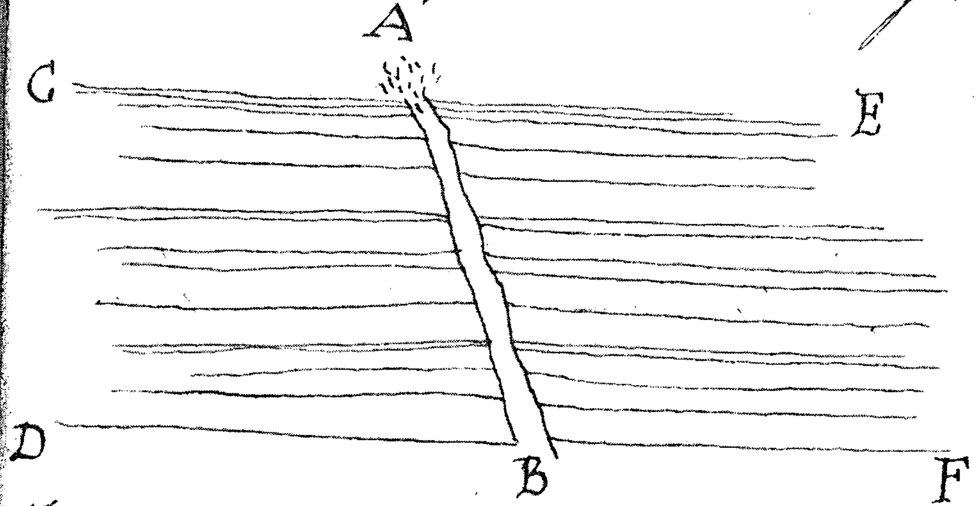
[93] Walker's later library contained a copy of Alexander Pennecuik's *A geographical, historical description of the shire of Tweeddale; with a miscelany and curious collection of select Scotish poems* (Edinburgh: 1715) EC 73.

Moffat and Annandale. From 1753 to 1757, he lived in Galloway where he toured its moors and dales as well as the Stewartry of Kirkudbright. During these trips, he collected the marl and manure samples that attracted the attention of Cullen and the Philosophical Society. In 1758 Walker went to live in Glencorse (also spelled Glencross) and also travelled with Cullen to Breadalbane. During the next three years he toured Fife, the shores of the Tay, Kinnoul Hill, Clackan, Annanshire, the silver and cobalt mines of Alva and the copper mine of 'Aithrey'.

In 1762 Walker moved to Moffat and lived there for the next twenty years. These Moffat travels (1762-1782) were even more extensive. As he would later state: 'During my long Residence in Moffat, I collected in a Number of short tours, all the remarkable Fossils in Dumfriesshire, the Forest of Selkirk, Teviotdale, Ayrshire, and Clydesdale' (Plates 3.II and 3.III).[94] Additionally, he visited the lead mines of Machrymore (Machermore), Leadhills and Wanlock, the copper mines of Covend and the antimony mines of Eskdale. He made over thirty trips to Leadhills and Wanlock on account of their close proximity to Moffat. There, between 1761 and 1764, he observed many minerals (strontite and zeolite in particular) that had not been previously seen in Britain. Walker would later state these 'new' minerals to be: '[T]he Ore, and the Ochre of Nickel; the Plumbum pellucidum of Linnæus; the Plumbum decahedrum and cyaneum, both undescribed; the Saxum metalliferum of the Germans; the Ponderosa aërata of Bergman; and the Morettum, which afterwards appeared to be a sort of Zeolite.'[95] As his comments on Fabricius and Cronstedt indicate, his interest in zeolite was originally related to talc, i.e. a potential Primary Earth. Furthermore, his research on strontitic 'earth' led to its later chemical classification.[96] Other short travels during this Moffat period include a 1765 journey to London[97] and his 1778 trips to Stirlingshire, Perthshire, Fofarshire, the Mearns and Aberdeenshire. Walker moved to Colinton (near Edinburgh) in 1782 and remained there until he died in 1803. During this time, he was first busy with lecturing and then slowly began to lose his eyesight. As a result, his short trips were limited and he depended more upon the observations of students and correspondents.[98]

[94] Walker (c. 1795), f. 5.
[95] Walker (c. 1795), ff. 5-6; Walker (1822), 89.
[96] '[T]o Dr. Walker the merit is due of having determined mineralogically that Strontites was a new mineral species. Dr. Hope afterwards, by the *discovery* of the strontitic earth, added to the interest of the determination of Dr. Walker, and proved that stontites was also a new chemical species.' Walker (1822), f. '*'.
[97] John Walker, 'Mineralogical Journal from Edinburgh to London', in Walker (1808), 395-402.
[98] In addition to all the short trips listed above, Walker also toured the western side of England from Carlisle to Bristol. See Walker (c. 1795), f. 10 or Walker (1822), 91. At some point, he also visited Preswick and Cunningham. See Walker (1766-72), ff. 222-23 and ff. 216-219.

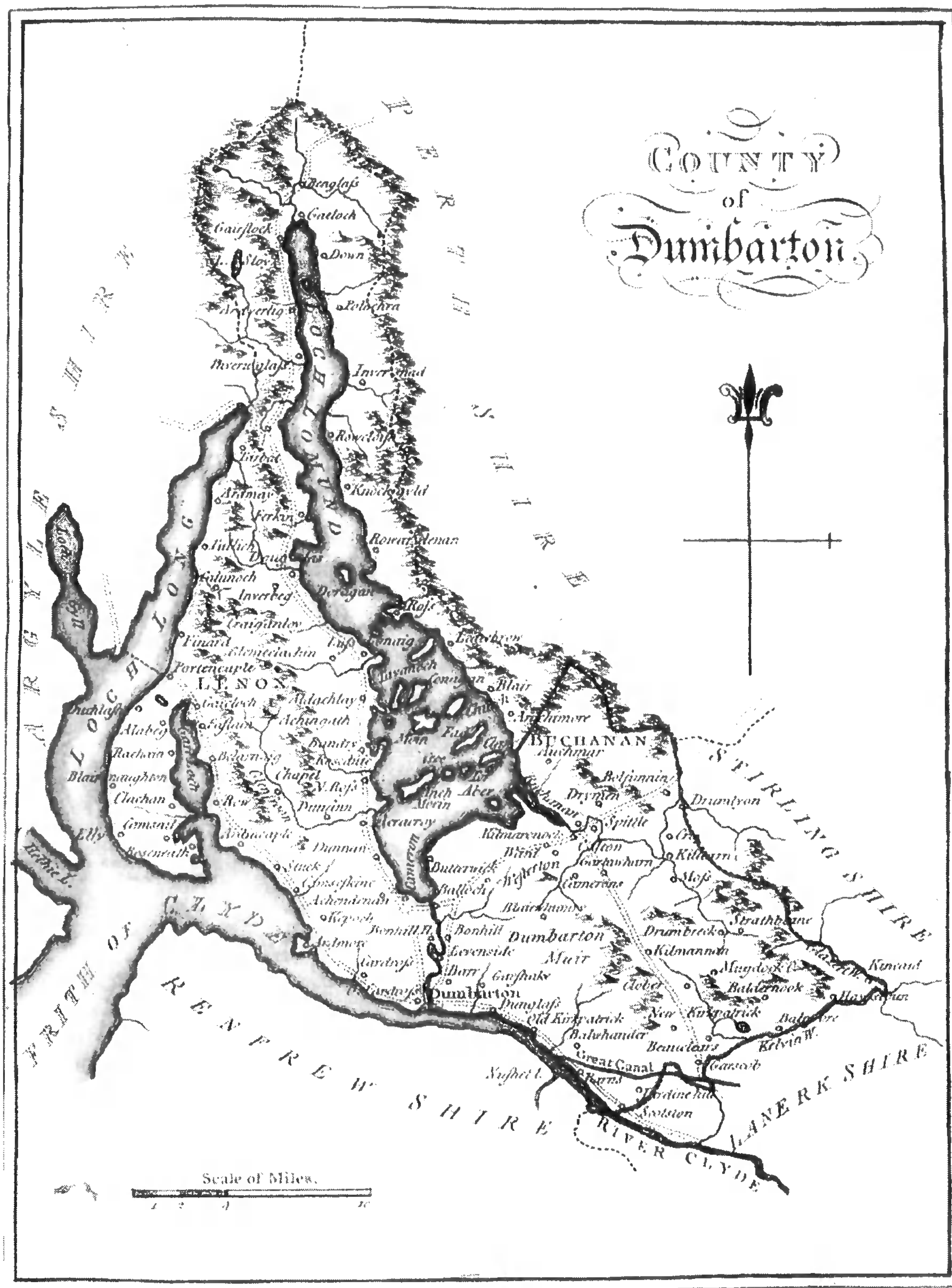
214. Substance between Whinstone, Freestone and Slate. It lies quite horizontal, & is cut by Fissures into Seams from half an Inch to a Foot in thickness.



In this Figure AB is the Vein, about a foot wide, & dips at an angle of about 80° down the Burn, and nearly in a South Direction. The Walls of the Vein, which are composd of horizontal Strata, are represented by the Lines from CD & from EF.
The Cockscomb rhomboidal Spar is the only one found in these Veins, of which they are full in some places, from Wall to Wall, & in this Spar, the small Masses of Lead are lodgd.

Walker's Notes on Strata, *c.* 1760s
Adversaria GUL MS Murray 327 ff. 213-214.

Walker took these observations from 'a small Burn which is one the most remote Heads of the River Air, in the Parish of Muir Kirk of Ryle, and upon the Earl of Loudan's Ground'.



Published as the Act directs by Robt. Sayer & Jno. Bennett 1st Nov. 1777.

County of Dunbarton, 1 November 1777
Mostyn John Armstrong (ed), *A Scotch atlas or, description of the Kingdom of Scotland*... (London: Robert Sayer 1787)

Walker's 1760s and 1770s notes indicate that he travelled this area quite extensively. He always took care to note specific details: 'The River Leven from the Clyde to Loch Lomond including its Turnings is 6¼ Miles long. It is navigable in a State of Nature from the Clyde to the Loch, for flat bottomed Vessels, in Winter & wet Season of Summer...' *Adversaria*, GUL MS Murray 327, f. 169. Several of Walker's future students would come from this area (one of the villages being Luss). This map shows how eighteenth-century place names are slightly different today. For example, Tarbat (above) is now Tarbet.

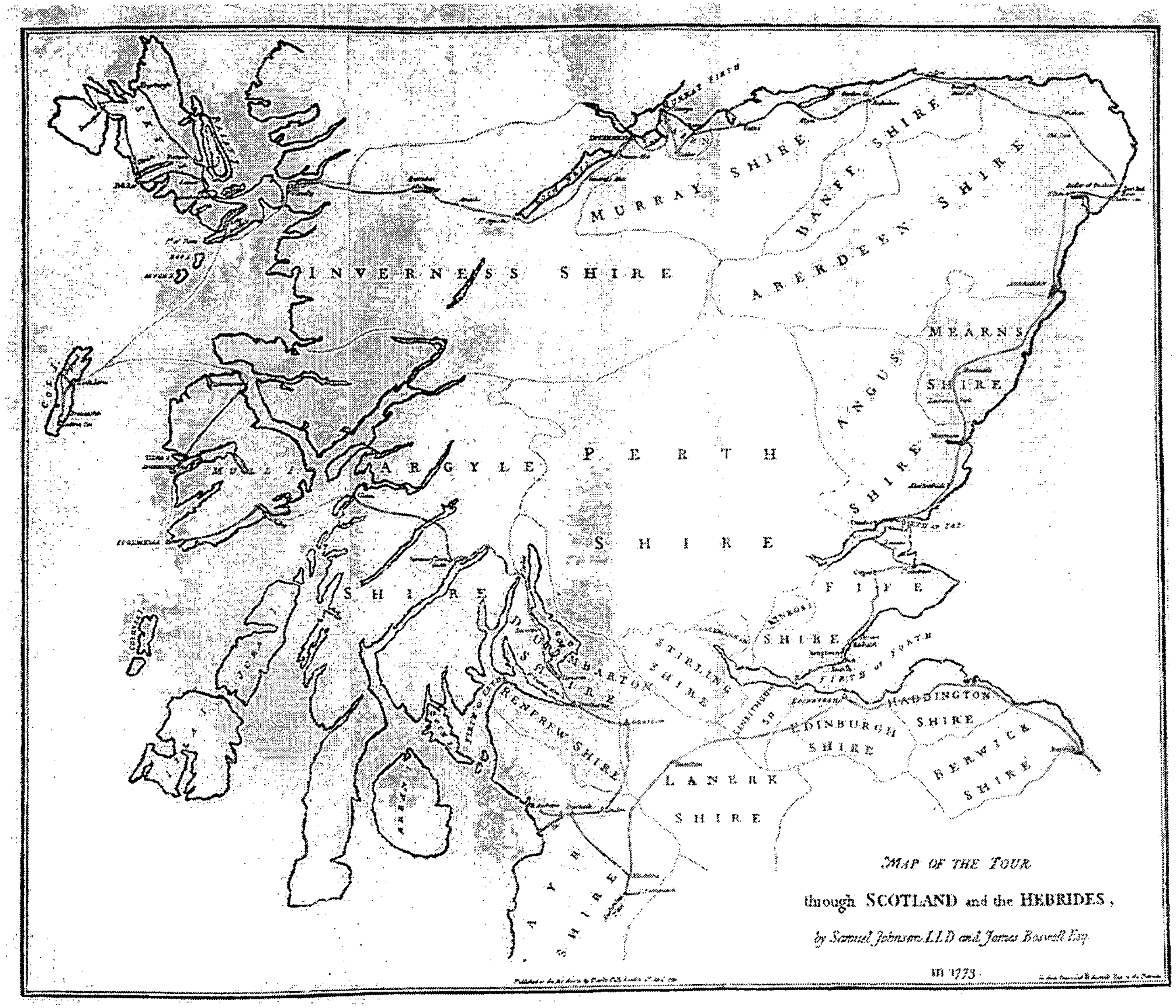
In addition to his short tours, Walker took two long tours to the Highlands and Hebrides. The first was in 1764 and the second was in 1771. These tours took place within the larger context of England's and Scotland's eighteenth-century fascination with the economic potential of the desolate areas north-west of the agricultural Lowlands. For instance, Walker's tours were complemented by those of Thomas Pennant (1769 and 1772) and Samuel Johnson (1773) (Plates 3.IV and 3.V). Additionally, the romantic implications of such travels engendered landscape paintings by artists like David Allen (Plate 3.VI). Walker's 1764 tour covered most of the Inner and Outer Hebrides and was more extensive. Both of these trips were dually supported by the General Assembly of the Church of Scotland and the Board of Annexed Estates.[99] Whenever observing minerals, he was keen to record: '1. The Qualities, local Uses, & indigenous Names to be marked' and '2. The most common Productions generally neglected.'[100] He also noted and/or collected the following:

1. *[The general chemical divisions of fossils.]*[101]
2. *Specimens of a large Size necessary.*
3. *The Want of sufficient Specimens, on Cause of the Imperfection of the natural History of Fossils.*
4. *Valuable Ores long considered as useless.*
5. *To collect the most common Rocks, Stones and Earths, especially those which prevail over a Country, or any considerable Tract.*
6. *The Walls of Vein, the Earths, Ochres & Fluors, as well as the Ores it contains.*
7. *To mark the Circumstances of their native Situation.*
8. *Whether the Fossile is in the Place where it has been generated*
9. *Proportion of Metal in the Ore – Size of Disposition of the Veins – Manner of working the Mines & smelting the Ores.*

Even though Walker states these directions to be more useful for a neophyte traveller, his later writings demonstrate that he followed a similar system when he traversed the wilds of Scotland. Like his chemical divisions of minerals, these instructions were probably not original to Walker. In fact, they bear a strong resemblance to the instructions given by Boyle, Woodward and Cullen. Concerning the preservation of samples, Walker recommended the following tools and precautions:

10. *Each Specimen to be put up separately & tallied with a Catalogue.*
11. *Tender Fossils to be put up in Cotton in Chip Boxes, & these again well wrapt & tied up in paper, because the Glue of the Boxes, sometimes gives way. Gems, fine Spars & Crystals,*

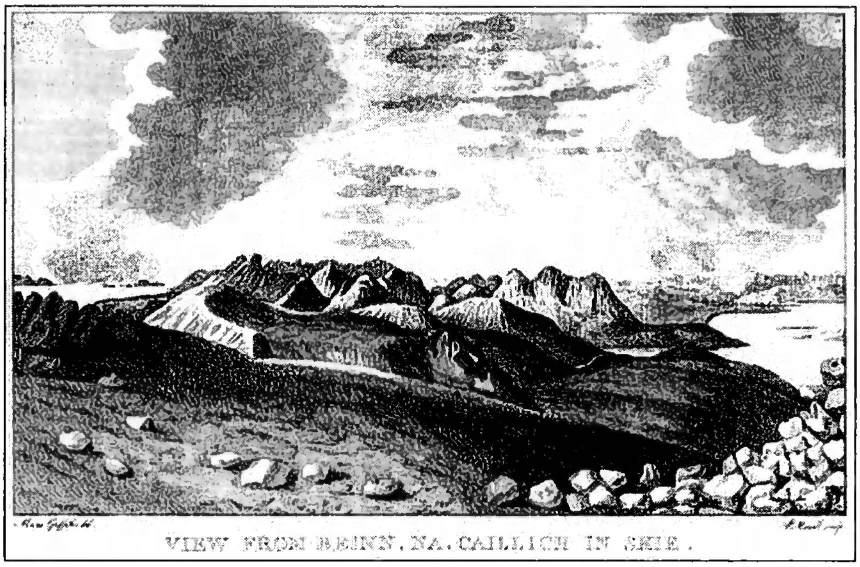
[99] As was mentioned in Chapter 1, he was awarded and honorary M.D. (University of Glasgow) and D.D. (University of Edinburgh) based on the scientific and theological research that he did on these tours.
[100] Walker, (1766-72), f. 156.
[101] As discussed in the previous section of this chapter.



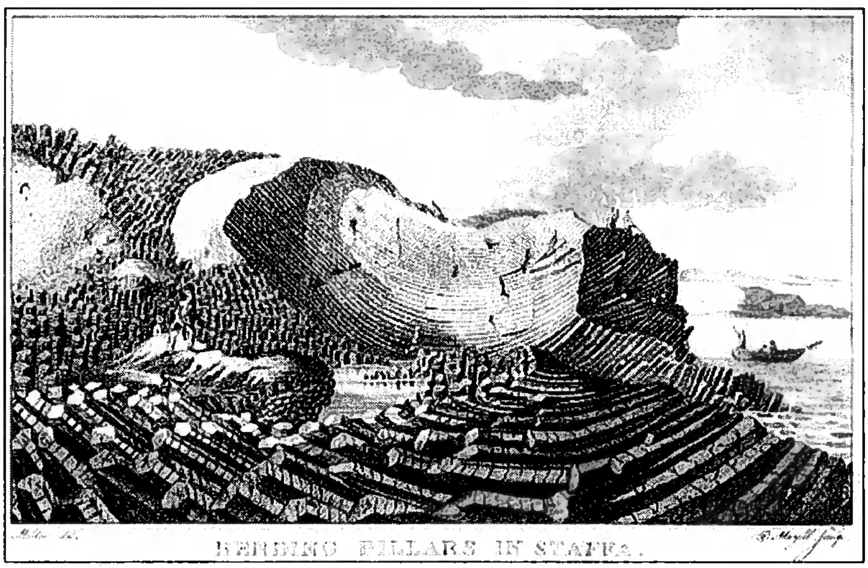
Map of Johnson's 1773 Tour
R. W. Chapman, *Johnson's journey to the Western Isles of Scotland* (London: 1930), *frontispiece*.

Johnson took his tour two years after Walker's second expedition to Highlands and Hebrides. Johnson's travels were rather tame compared to Walker's trips to the tops of mountains and to the remote bays of Outer Hebrides.

Chapter 3. Plate IV.



Pennant's Isle of Skye



Pennant's Isle of Staffa

Both illustrations taken from Thomas Pennant, *A tour in Scotland and voyage to the Hebrides, 1772* (Chester: 1774).

Pennant was travelling in the Hebrides and Highlands at the same time as Walker. Because Walker had travelled in the area during 1764 and 1771, Pennant had originally wanted him to come along on the trip but circumstances prevented it. Later in his career, Walker would use his personal observations from Staffa to assert that basalts were formed in water.

A Highland wedding at Blair Athloll 1780
David Allan (1744-1796)
National Gallery of Scotland, Edinburgh

Landscape was featured prominently in mid and late eighteenth-century Scottish painting. In such works, mountains and mineralogical formations played a supporting or leading role in the composition. The interaction between folk traditions and nature was often noted by travelling naturalists. Walker was no exception and his notes often blend ethnographic observations with those about the a given area's plants, minerals and animals.

Chapter 3. Plate VI.

Stalactites, Asbestos, Crystals of Salts & Vitriols, Superficial Delineations, figured or lucid Ores, & most sorts of Petrifactions & figured Fossils require this Precaution

12. The several Parcels to be packed up in Barrels or strong Boxes, with plenty of Paper, Cotton, Tow or some such soft Substance.

13. Iron Cron. Pocket Spade. Hammers. Chip Boxes. Paper of different kinds. Pack Thread. Cotton. Canvass Bags.[102]

Using these directions, Walker made observations and collected a wide variety of samples that allowed him to write a detailed report on the Hebrides for King George III. This report is now known as the *King's MS*. It was based on his 1764 journey and took him seven years to write. The preface of the *King's MS* is addressed 'TO HIS MAJESTIES COMMISSIONERS AT THE BOARD OF ANNEXED ESTATES'[103] and it states: 'The following History of the western Islands, undertaken at your Desire and executed under your patronage, I have endeavoured as much as possible to render subservient to your excellent and Patriotic Designs.'[104] As a representative of the Crown's improving landlords, it was his duty to identify minerals that were of economic value—lead, coal, marble and metals being the most notable.[105]

At first glance, the plethora of physical observations in the *King's MS* might suggest that Walker had forgotten his chemical mineralogy. However, this was not the case. The fact that he cited many minerals in relation to the work of authors like Wallerius and Cronstedt would have attracted the interest of Scottish chemists.[106] An excellent example of the chemical relevance of his observations is in the section of the report on the Isle of Skye. Here Walker mentions that he has found a Talcy Earth similar to that used for making China in Cornwall. 'I have as little doubt, that this Talc of Sky, is superior to the Soap Rock. It is of a most pure and impalpable Substance, of itself, *the most unalterable in the fire* perhaps, of any Fossile, Gold only excepted.'[107] This test upon Talcy Earth served two important chemical goals. First, it would have aided Black and Cullen in their deliberations about Talc's status

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[102] Walker (1766-72), ff., 157-158.

[103] The Board of Annexed Estates was set up to oversee the lands that had been confiscated by the Crown after the 1745 Jacobite Rebellion. Governed by a council of nobles, it was to this body that Walker addressed his report. One of the goals of the Board was to determine whether or not the land could be economically improved and whether or not there was still a strong Catholic presence.

[104] See McKay's introduction in Walker (1980), 1-30. Also see [Anon.], 'Dr. John Walker's report to the assembly 1 – 65, concerning the state of the highlands and the islands', *Scots magazine* (1766), **28**, 680-689; [Anon.] 'Dr. Walker's report concerning the state of the Highlands and Islands, to the General Assembly 1772', *Scots magazine* (1772), **34**, 288-293.

[105] Walker (1980). He specifically comments about the coal deposits on the islands of Gigha, Rhum and Eigg. Coal's role in the development of eighteenth-century mineralogy is briefly treated in H. Torrens, 'The History of Coal Prospecting in Britain 1650-1900', in 11th Symposium of the International Cooperation in the History of Technology Committee (ed.), *Energie in der Geschichte* (Düsseldorf: 1984), 88-95.

[106] In addition to citing Wallerius and Cronstedt in the *King's MS*, he also mentions the mineralogical works of John Ray, Hans Sloan, Linnaeus, [Louis?] Esteve, James Balfour and Robert Sibbald. See Walker (1980), 143, 163, 189-191, 198-199 and 215-219.

[107] Emphasis added. Walker (1980), 218.

as a Primary Earth. Their views on this matter were closely related to several other experiments Black had conducted over the past decade to determine whether or not other substances like alum and magnesia alba were products of calcareous earth. These types of experiments had been initiated by Andreas Marggraf and Johann Pott at the Berlin Academy a decade earlier.[108] Second, since the 1750s Cullen had been searching for a Scottish clay that could be used to make porcelain (this was why he had originally consulted Pott). It was for this reason that Walker used his fire experiment to argue that the Talc from the Isle of Skye was just as suited for manufacturing China as the 'apyrous' clay (kaolin) used from Stourbridge and other places in the English Midlands.

In all of his travels from the 1750s to the 1770s, Walker's chemistry played an important role in how he actually gathered mineralogical samples. The only way that he could determine whether or not the manure from Kirkudbright or the Talc from Skye were relevant to other chemical mineralogists was to perform preliminary tests in the field or at home that would reveal whether or not certain minerals were worth sending to Edinburgh for further analysis. This would not have been hard since the two main tests (fire and acids) did not involve elaborate apparatus[109] (however, it is worth saying that Walker does not mention Cronstedt's blowpipe technique).[110] Once the samples were in Edinburgh, this allowed him and others to conduct more experiments upon them. Moreover, it was these private specimens that would eventually form the core of the 'public' mineralogical collection of Edinburgh University's Natural History Museum.[111] Over the next thirty years, the chemical characters obtained from such fossils played a key role in the classification system that he taught his natural history students during the 1780s and 1790s.[112] Since his classification was based on Primary Earths, the very categories created by each genus and species led him to investigate specific chemical characters of select fossils – Talc, once again, being a good example of this specialised interest.

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[108] For Alum, the question was whether or not it was an alkaline Calcareous Earth. See F. L. Holmes, *Eighteenth-century chemistry as an investigative enterprise* (Berkeley: 1989), 49-55.

[109] Sometimes an acid test could be performed by simply tasting the object under consideration. For instance see his treatment of the South Uist's *polygonum amphibium*: Walker (1980), 76.

[110] This could be because Cullen only gave Walker a partial translation of Cronstedt's classification, thereby possibly preventing Walker from knowing about Cronstedt's blowpipe. The fact that Walker does not mention the field use of this test confirms (at present) Staffan Müller-Wille's belief that the instrument was generally confined to laboratory usage. See Müller-Wille's paper given at the History of Science Society Annual Meeting at Denver, Colorado. Session: 'The creation of order: scientific classifications in the eighteenth and nineteenth centuries', November 10, 2001.

[111] Walker's keepership formed a unique private/public situation. See C. W. J. Withers, ''Both Useful and Ornamental': John Walker's Keepership of Edinburgh University's Natural History Museum, 1770-1803', *Journal of the history of collections*, **5** (1993), 65-77; Anderson (2000), 22; Waterston (1997), 11. The transfer from private to public collections during this time is also treated in E. P. Hamm, 'Unpacking Goethe's Collections: The Public and Private in Natural History Collecting', *BJHS*, **34** (2001), 275-300.

[112] See the mineralogy sections of David Pollock's 1797 notes from Walker's lectures: *Epitome of Natural History*, Vols. 4- 9. EUL Gen. 706.D-711.D

Correspondents, Patrons and Collecting Fossils

Whether or not Walker was observing the chemical or physical characters of Scottish minerals, he still needed samples from home and abroad that could function as a source of comparison. In addition to the minerals that he collected on his personal travels in Scotland, the specimens that he acquired during the 1750s and 1760s came from two other sources: correspondents and patrons. Although he had been in contact with Linnaeus since 1762,[113] it was Walker's 1765 trip to London that enhanced his correspondence network. He was received by English naturalists, like John Ellis, who were familiar with his name because of his Linnaean credentials and his *Philosophical Transactions* article.[114] Scottish naturalists living in London would have also known of him on account of his travels and connections in their home country. This connection back to Scotland was important because the political situation of the mid-eighteenth century had created a closely-knit Scots community in London. Overseeing this network were two political magnates Lord Bute and his brother James Stuart Mackenzie. It seems that Walker was received into this community on account of his intent to publish a natural history of Scotland[115] and because he knew Bute. He used this visit to obtain correspondents who were not only willing to trade minerals, but also botanical and zoological specimens.[116]

While in London, Walker was also put into contact with one of the most well known fossil traders in Britain: 'Mr. da Costa, author of the History of Fossils, and then Librarian to the Royal Society.'[117] During the 1760s, da Costa provided Walker with a wide variety of minerals. He sent him thirty-one 'Articles' in 1765 and twenty-nine in 1769.[118] How Walker paid for these is not certain. He most probably received them in exchange for sending Da Costa samples from the Highlands and Hebrides. Da Costa would have been particularly keen on obtaining Scottish minerals on account of England's rising interest in the natural history of 'North

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[113] Several of these letters can be found in EUL, La.III.252/1. Some of these have been printed in Scott's edition of Walker's lectures and in J. E. Smith's *A Selection of the Correspondence of Linnaeus* New York: Arno Press, 1978).

[114] John Ellis to Linnaeus, 29 October 1765, in James E. Smith (ed.), *A selection of the correspondence of Linnaeus and other naturalists* (New York: 1978), 180.

[115] William Walison to Richard Pulteney, 29 October 1765, National Library of Scotland (subsequently NLS) Acc. 9533, No. 314.

[116] The most fruitful botanical connection Walker made was Dr. Richard Pulteney, with whom he exchanged both plants and seeds. See Walker to Dr. Pulteney, 3 June 1768 and Dr. Pulteney to Walker, October 1768, Linnean Society Manuscripts No. 238. Facsimilies housed in NLS Acc. 9533, No. 314.

[117] Walker (c. 1795), f. 10.

[118] Here it is worth noting that Walker's entire list of mineralogical suppliers (which is included in the original MS of *Systema Fossilium* (c. 1795), ff. 10-18, is omitted from the 1820 printing of *Systema Fossilium's* preface. There is also a curious list of 'Prices of some Fossils & Shells sold at an Auction in London. Jan^r 1766' in Walker's *Adversaria* that might have been sent by Da Costa. Walker (1766-72), ff. 136-137.

Britain'.[119] The Da Costan fossils came from England, Brazil, Hungary, Florence, Russia, Sweden, Norway, Pennsylvania, Peru, Bohemia, France and several German principalities and kingdoms (including Saxony).[120] In between these two shipments from Da Costa, Walker also obtained 'A Collection of other Fossils brought from Italy by Mr. John Sivewright of Southhouse'. Sivewright had recently died and Walker obtained sixty-nine specimens via the deceased's sister during 1768.[121] Over the next thirty years, Walker continued to collect minerals in such a manner. He also began to hire lapidaries to find specific fossils.[122] As he became part of the British mineralogical trade, his own network expanded and this placed him in contact with other willing suppliers and traders. For instance, his *Systema Fossilium* states that in 1772 he received fossils from 'Mr. George Wilson, Surgeon in London' and 'Miss Blackburn from Orford'.[123] A key point to note about these fossils is that, like the samples he collected himself, Walker subjected many of the specimens to chemical analysis—as can be seen by the *ferrum intractable nitens micaceum* debate already detailed above.

Walker's other mineralogical source during the 1760s was aristocratic patrons. His initial contact with the aristocracy was through William Cullen. It was Cullen's chemical knowledge that had originally allowed him to make his own contacts among the nobility.[124] During the 1750s Cullen was involved in introducing Walker to Lord Kames and to the Clerk family of Pennicuik.[125] Walker's travels in the mid 1760s furthered his reputation as Cullen's protégé and placed him contact with aristocrats like the Earl of Loudan (on whose land Walker sketched coal strata).[126] These tours and his connection with Lord Kames promoted Walker as a credible naturalist and led the Board of Annexed estates to select him for the 1764 tour of the Hebrides and Highlands.[127] In addition to establishing contacts with

[119] This interest was soon confirmed by the popularity of Thomas Pennant's tours (1769 and 1772) and by Johnson and Boswell's 1773 tour. See Pennant's *A tour in Scotland 1769* (Edinburgh, 2000) and *A tour in Scotland and voyage to the Hebrides 1772* (Edinburgh: 1998); S. Johnson, *Johnson's journey to the Western Islands of Scotland and Boswell's journal of a tour to the Hebrides with Samuel Johnson, LL.D* (London: 1930).

[120] Walker (1766-72), ff. 144-152 and 174-175. The Pennsylvanian minerals could have possibly come from Benjamin Franklin, who Walker lists in his *Systema Fossilium* (c. 1795) as a source for his mineralogy collection, f. 18.

[121] Walker (c. 1795), f. 10.

[122] Walker uses the term 'Lapidary' to describe a person who buys or trades minerals.

[123] Walker (c. 1795), f. 12.

[124] Cullen had first met the Duke of Argyll on account of His Grace's desire to obtain chemistry apparatus. By 1751, Cullen was discussing chemistry with Argyll via correspondence. See: 'Drafts of four letters from William Cullen to the Duke of Argyll on the subjects of fossil alkali and salt production', GUL, GB 247, MS Cullen 60. Cullen also had strong links to the Duke of Hamilton and his family. For an excellent article on this relationship, see R. L. Emerson, 'The scientific interests of Archibald Campbell, 1st Earl of Ilay and 3rd Duke of Argyle (1682-1761)', *AS*, **59** (2002), 21-56. See also D. Guthrie, 'William Cullen and his times', in J. W. Cook (ed), *An eighteenth lectureship in chemistry*, (Glasgow: 1950), 50-51.

[125] It is also likely that Cullen introduced Joseph Black to the Pennicuik family, a relationship that blossomed in the 1770s. See Thomson (1830), 328-329.

[126] Walker (1766-72), ff. 213-215.

[127] Cullen was also busy promoting Walker to other naturalists like Thomas Pennant: 'I take the liberty of recommending to Mr. Walker a thorough Attention to the Zoology of the Western Isles.' Thomas Pennant to William Cullen, 21 April 1764, EUL La.III.352/1 ff. 9-10.

Baron Mure, Baron Cathcart, Lord Queensbury and Lord Hopetoun, the 1764 tour allowed Walker to befriend Lord Bute. Over the next ten years, Walker functioned as a scientific advisor to all four of these men.

Most Scottish land-owners were interested in mineralogy and chemistry because of their close links to mining and land improvement. It was for this reason that Walker was keen to copy down Cullen's (*circa*) 1766 *Lectures on Agriculture*[128] and to offer colliery observations (like those he made for the Earl of Loudan). Walker was not the only one to use chemical mineralogy to obtain patronage. Black, Cullen's other protégé, followed the same pattern.[129] In addition to questions of land improvement, members of the landed-class also consulted men like Walker, Black and Cullen because they were interested in writing their own treatises on georgics—Kames's *Gentleman Farmer* (1779) being a good example.[130] Quite often, such agricultural and mineralogical advice paved the way for political connections and preferential access to large tracts of land. For instance, it was Hopetoun's Wanlock and Leadhills mines that afforded Walker the most detailed view of underground minerals and his mineral well (Hartfell Spa, outside of Moffat) that allowed Walker to publish his first article.[131] Acquiring these minerals also led to their analysis, both for reasons of science and patronage.[132] This symbiotic relationship between land improvement and natural history was one of the main factors that propelled Walker's career, especially when the town council appointed him to be the professor of natural history in 1779.[133] Moreover, based on the careers of Walker, Cullen and Black (and others like professors Charles Alston and Francis Home), it seems that mid eighteenth-century Scottish mineralogy thrived on a reciprocal relationship that existed between improvement minded patrons and naturalists that were either employed in or trained by the medical schools. If one looks at the chemical experiments being performed on minerals by Edinburgh's Medical School professors

[128] John Walker (transcriber), *Abstract from Dr. Cullen's lectures on agriculture* (c. 1766), EUL Dc.3.70. J. Thomson sets the date of these lectures to be *circa* 1766 in his *An account of the life, lectures, and writings of William Cullen vol. I.* (Edinburgh: 1859), 64. For more information on these lectures, see C. W. J. Withers, 'Improvement and Enlightenment: Agriculture and Natural History in the Work of the Rev. Dr. John Walker (1731-1803)', in *Philosophy and science in the Scottish Enlightenment*, P. Jones (ed), (Edinburgh: 1988), 102-116; 'A Neglected Scottish Agriculturalist: the 'Georgical Lectures' and Agricultural Writings of the Rev. Dr. John Walker (1731-1803)', *AHR*, **33** (1985), 132-143.

[129] As demonstrated by the mineralogy letters exchanged between Black and Lord Hopetoun, in the previously mentioned correspondence collection of EUL MS Black 873-5.

[130] Also see C. W. J. Withers, 'On Georgics and Geology: James Hutton's 'Elements of Agriculture' and Agricultural Science in Eighteenth-Century Scotland', *AHR*, **42** (1994), 38-48.

[131] Several other naturalists visited these mines throughout the seventeenth and eighteenth centuries. See T. C. Smouth, *Report on the lead-mining paper at Hopetoun House, West Lothian, 1625-1799* (Edinburgh: 1962) and M. D. Eddy, 'James Hope Johnstone, third Earl of Hopetoun (1741-1816)', *NDNB* (forthcoming: 2004).

[132] Porter argues that 'From 1700 until 1775... most mineralogists felt that their chief task was to integrate mineralogy and chemistry, for the benefit of mineralogy.' T. Porter (1981), 548.

[133] See S. Shapin, 'Property, Patronage, and the Politics of Science: The Founding of the Royal Society of Edinburgh', *BJHS*, **7** (1974), 1-41.

who taught chemistry or *materia medica*,[134] it becomes apparent that many of their experiments were directly applicable to mineralogical and chemical classification. In this sense the Medical School provided a key service that was characteristically associated with mining academies in Europe.[135]

Walker's most significant aristocratic patron was Lord Bute. Like Kames, Bute's interest in natural history went beyond simple land improvement. In addition to its economic value, natural history was Bute's favourite hobby.[136] He had taken his degree from the University of Leyden in 1732 and, like many naturalists, he was not content with the Linnaean classification system.[137] This led him to construct his own.[138] In 1765 Bute gave Walker access to his London library[139] and by 1767 it is highly likely that Bute was supplying specimens to 'the ingenious Doctor Walker of Moffat'.[140] Bute must have thought highly of Walker's abilities because he discussed his alternative classification with him. Walker specifically recorded Bute's thoughts on the classification of gems and flowers in his *Adversaria*.[141] To help develop his system, Bute had amassed a large collection of minerals and plants from Britain and abroad. Wilson has suggested that his mineralogical collection was well over 100,000 specimens. If this is true, Bute's collection was possibly the largest in Europe at the end of the eighteenth century.[142] Bute allowed Walker to see part of his 'fossil' catalogue sometime during the late 1760s. In the notes that Walker took on the collection, he states that Bute had purchased some of the minerals from a Mr. Maine for the sum of £300. Walker was able to view '1833 Numbers of Fossils, many of which, are English & Foreign.' Of these, Walker copied down sixty Scottish specimens and twenty 'Foreign Fossils, chiefly German'—the latter being

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[134] J. Black (EUL MS Black 873-5). Aside from the mineralogical sections on Cullen's chemistry lectures discussed in the first section of this essay, see Joseph Black's sections on 'earths' (Cochrane: 1966) and the entries on mineralogical simples contained in the *material medica* lecture notes of Alston and Home that are housed in the Royal College of Physicians of Edinburgh. See especially Alston's *Lectures on materia medica*. 12 vol. [Edinburgh, c.1740] and Home's *Lectures on materia medica*. 2 vol. [Edinburgh, c.1768].

[135] For a general introduction to the role of mining academies see M. Guntau, 'The Natural History of the Earth', in *Cultures of natural history*, N. Jardine, J. A. Secord and E. C. Spary (eds), (Cambridge: 1996), 211-229; D. Brianta, 'Education and Training in the Mining Industry, 1750-1860: European Models and the Italian Case', *AS*, **57** (2000), 267-300. Unfortunately, Brianta's analysis conflates 'Britain' with 'England' (thereby ignoring trends in Scotland). See pages 280-281.

[136] D. P. Miller, ''My Favourite Studdys': Lord Bute as Naturalist', in Karl W. Schweizer (ed), *Lord Bute: Essays in re-interpretation* (Leicester: 1988), 213-239. Also the anonymous *A Catalogue of the capital collection of optical, mathematical, and philosophical instruments and machines: late the property of the Right Hon. the Earl of Bute*... (London: 1793). One of the only known copies of this is housed in Imperial College's Science Museum Library. Furthermore, the 'Walker' listed as buying lots 79, 211, 227 and 233 just might have been John Walker – not Adam Walker as G. L'E. Turner has proposed in 'The Auction Sales of the Earl of Bute's Instruments, 1793', *AS*, **23** (1967), 213-242, see esp. pages 221 and 227.

[137] John Hill (1716-1775) for example. F. A. Staflau, *Linnaeus and the Linnaeans: The Spread of Their Ideas in Systematic Botany, 1735-1789* (Utrecht: 1971), 207-210; 231.

[138] Eventually published as *Botanical tables, containing the different families of British plants distinguished by a few obvious parts of fructification rang'd in a synoptical method* (London: 1784). Also see R. Desmond, *Kew: The history of the Royal Botanic Gardens* (London: 1995), 92.

[139] Walker (1766-72), f. 200.

[140] D. S. Erskine to Bute, 23 March 1767, Cardiff, MSS, Bundle 2. Also quoted Miller (1988), 238.

[141] Walker (1766-72), f. 194-195.

[142] Wilson (1994), 69-70.

mostly metals.[143] Walker continued to maintain his relationship with Bute into the 1770s. He visited the Isle of Bute during his 1771 tour and in 1772 Bute sent Baron Mure two letters enquiring about a box of books that he had bought for Walker in London.[144]

Bute and Walker's other patrons placed him in contact with their natural history network at home and abroad. In Britain, Walker's ties with Bute advanced his standing with the natural history community in London, especially after he had corresponded with the famous naturalist Sir Joseph Banks.[145] Walker's ties with Kames brought him into contact with several of the Judge Advocate's scientific advisors—two examples being Sir John Nasmyth (c.1704-1779)[146] and Sir John Pringle (1707-1782).[147] The fact that Walker had been trusted by the nobles who sat on the Board of Annexed Estates most likely gained him an introduction to the Duke of Northumberland in 1765.[148] However, Walker's contact with Northumberland may have been encouraged by Bute.[149] Walker's notes and letters from the 1750s through the 1770s further indicate that he was in contact with several landed families[150] as well as several of Edinburgh's Judge Advocates.[151] Since many of these land-owners actively maintained natural history contacts abroad, Walker benefited from their extended network. The best example of this situation is a letter written from Dr. John Rogerson to John Clerk, the seventh son of Sir John Clerk of Pennicuik.[152] Rogerson was a former student of Cullen. He was the personal

[143] Walker (1766-72), ff. 178-186.

[144] Lord Bute to Baron Mure, 25 March 1772, NLS, Mure of Caldwell Correspondence, MS 4945; Lord Bute to Baron Mure, 14 August 1772, NLS, Mure of Caldwell Correspondence, MS 4945. Part of the former letter states: 'I have taken the liberty to send a box of books for Dr Walker; to [?] address that I beg you would forward him.'

[145] Walker to Joseph Banks, 28 March 1767 and Walker to Joseph Banks, 23 January 1772, in *The Banks letters: A calendar of the manuscript correspondence of Sir Joseph Banks, preserved in the British Museum, the British Museum (natural history) and other collections in Great Britain*, W. R. Dawson (ed), (London: 1958), 849. (Both letters are on this page).

[146] Walker, (1766-72), ff. 224, 227, 228-229. Naysmyth studied with Linnaeus in Sweden and was elected fellow of the Royal Society in 1767. See G. E. Cokayne, *Complete baronetage, Vol. IV* (Gloucester: 1983), 441.

[147] John Pringle to Walker, 19 February 1778. The letter is lost, but is referred to it in Walker's 28 February 1788 letter to Lord Hailes, NLS, MS 25303, ff. 5-6. Pringle was Scottish, and was made physician to the Queen (1761) and then to the King (1764). He was elected President of the Royal Society in 1772 and was directly involved in editing the 1774 edition of the *Edinburgh pharmacopoeia*. For the latter see D. L. Cowen, *Pharmacopoeias and related literature in Britain and America, 1618-1847* (Aldershot: 2001), 38-40.

[148] Walker visited him during his 1765 trip to London. It seems that the Duke of Northumberland and Walker even had several detailed conversations about the differences between Scottish fir and pine trees. Walker (1766-72), ff. 128-131.

[149] Northumberland and Bute were discussing natural history as early as the 1750s. It was Northumberland who had introduced John Hill to Bute. Miller (1988), 219.

[150] Most were Scottish nobles: (1) John Boyle, Earl of Glasgow (1714-1775). (2) David Stuart Erskine, Earl of Buchan (1742-1826). (3) George Macartney (1737-1818), who Walker calls 'Lord Auchinleck', was knighted in 1764, sent as Britain's Envoy to Russia (1764-1767) and was made Baron in 1776. (4) Sir William Maxwell. (c.1715-1771). (5) George Clerk (1715-1784), second son of Sir John of Pennicuik. Styled Sir George Clerk-Maxwell, (1782) and served as Scottish Commissioner of Customs (1763-1784). Walker was also in contact with the Englishman Sir John Hussey Delavel (1728-1808) of Ford, Northumberland. Delavel was also a keen mineralogist. See *DNB*.

[151] (1) The aforementioned Henry Home, Lord Kames. (2) Sir David Dalrymple, (1726-1792), styled 'Lord Hailes' when he was made a Judge Advocate for the Scottish Court of Session in 1766. (3) Francis Garden (1721-1793), styled 'Lord Gardenstone' when raised to the bench in 1764.

[152] The stratigraphical drawings of John (the younger) were originally supposed to be included in Hutton's *Theory of the Earth*. See James Hutton (ed.), *James Hutton's theory of the earth: Reproductions of drawings, mostly by John Clerk of Eldin*, (Edinburgh: 1978).

physician to Catherine the Great and several other members of the Russian court in St. Petersburg. The letter states:

I wrote Dr. Walker last Autumn and sent at his requisition upwards of an hundred specimens of Russian and Siberian Ores which I hope he has received safe – I think they were addressed to the Care of the Jamiesons of Leith. Dr. Pallas Professor in our Academy and a Man of first rate mint and knowledge furnished me with almost all of them. I should be glad to open correspondence between Dr. Walker and him – he writes and speaks English so it would be perfectly easy for both and might be mutually usefull to each other.[153]

Rogerson was part of a larger network of Scottish physicians who lived on the Baltic and who helped supply mineralogical specimens.[154] Many of them were associated with port cities that contained large British trading communities. They collected a wide variety of minerals and sent them back to British naturalists and landowners seeking to compare their ores, minerals and metals to those from abroad.[155] During the 1760s, this network flourished under the patronage of Baron Charles Cathcart, the British Ambassador to Russia. Walker was included in this network because he had formed close links to the Cathcart and Hopetoun families. As the above excerpt indicates, the mineralogical rewards of such a network would have no doubt provided more specimens that would eventually help him write his own mineralogical system.

Conclusion

This chapter has detailed Walker's early mineralogical career, with specific focus being paid to how he analysed, arranged and acquired 'fossils'. It began by showing that chemistry probably was the main form of analysis used for ascertaining mineral characters in eighteenth century Scotland. Although he was familiar with other theories, Walker was most influenced by five-principle chemistry. He was introduced to this when studying at the University of Edinburgh and via his mentor

[153] Dr John Rogerson to John Clerk, 23 August 1772, National Archives of Scotland, GD 18/5121/3. The letter is dated from St. Petersburg. It also mentions Dr Hope and seed specimens that were collected for Catherine the Great by Professor Laxman. The connection with Pallas would eventually find fruition in 1783 when he sent Walker one-hundred and twenty-nine fossils from Siberia for Edinburgh's Natural History Museum. Whithers (1993), 70.

[154] The Baltic had a thriving mineralogical trade at this time. Most of the port cities traded minerals that could be used for aristocratic collections, mining and pharmaceuticals. It seems that the two nodes of the mineralogical trade were Copenhagen and St. Petersburg. This trade later allowed the British navy to gain money by seizing mineral shipments during the Napoleonic Wars. Whitaker (2001), 465. However, this trade would have been seriously damaged when Lord Cathcart took Copenhagen in 1807. M. D. Eddy 'Sir William Schaw Cathcart, tenth Baron Cathcart... (1755-1843)', *New Dictionary of National Biography*, Brian Harrison (ed), (Oxford, forthcoming 2004).

[155] See J. H. Appleby, 'A Survey of Some Anglo-Russian Medicinal and Natural History Material in British Archives, from the Seventeenth Century to the Beginning of the Nineteenth Century', in *The study of Russian history from British archival sources*, Janet M. Hartley (ed), (London: 1986), 107-131; A. G. Cross, 'Articus and *The Bee* (1790-94): An Episode in Anglo-Russian Cultural Relations', in *Oxford Slavonic papers, new series vol. II* (Oxford: 1969), 62-76. L. Koerner also treats various aspects of the Baltic mineralogy in 'Daedalus Hyperboreus: Baltic Natural History and Mineralogy in the Enlightenment', in *The sciences in Enlightened Europe*, W. Clark, J. Golinski and S. Shaffer (eds), 389-422.

William Cullen. This form of chemistry favoured the Becher-Stahl School's concept of a 'Primary Earth' that chemically analysed stones and then classified them based on which Primary Earth they contained. With the help of Cullen and Kames, Walker entered into the Scottish natural history scene during the 1750s and continued to use chemistry to ascertain the characters of minerals. Although the Swedes, Germans and French promoted chemical mineralogy at this time, it was the Swedish authors that had the most profound effect on the mineralogy practised by Walker and several of his contemporaries. He first used Wallerius and Cronstedt in the 1760s and then went on to use Bergman in the 1770s. As will be shown in the following chapters, the influence of Swedish mineralogy remained strong when he began to give his mineralogy lectures in 1780s and he continued to cite these authors up until he died in 1803.

Walker's career demonstrates that acquiring and analysing minerals in eighteenth-century Scotland was a symbiotic relationship. The best example of this situation was Walker's involvement with the Hope family. There is no doubt that his 1757 *Philosophical Transactions* paper would have pleased John Hope, the second Lord Hopetoun; because as Chapter 2 pointed out, Hartfell Spa (the medicinal well under examination) was on his land. It should therefore come as no surprise to see that Walker was appointed to be the minister of Moffat in 1762 – a town in which the Hope family exerted a considerable amount of influence (indeed, they donated the land on which the town's present church is built). Living in Moffat placed several of the Hopetoun mines within a day's walking distance. Even though it is not clear (at present) as to what extent Walker was involved in guiding the family's view on ore or coal prospecting, it is clear that he made himself available to give advice on the minerals being dug out of their mines.[156] The links that he made with Hope family early in his career became very useful later in his life. During the late 1770s, the second Lord Hopetoun helped Walker secure his professorship and gave him access to mineral specimens that he had acquire while travelling abroad.[157] After the second Lord Hopetoun died in 1781, James Hope, the third Lord Hopetoun continued to supply the Natural History Museum with specimens[158] and politically supported Walker's involvement in the creation of the Royal Society of Edinburgh in 1783.[159] To this day several of the marble slabs given by the Hopes to the Natural History

[156] In addition to Walker, the Hopetoun mines were also visited by Thomas Pennant and R. E. Raspe. See M. D. Eddy. 'James Hope Johnstone, third Earl of Hopetoun (1741-1816)', *NDNB* (forthcoming 2004)
[157] Waterston (1997), 22.
[158] Lord Hopetoun is also listed as a patron of the museum in a report written by Walker *circa* 1786. EUL La.III.352/5 f. 1.
[159] Shapin (1974) treats the larger political situation that influenced Walker's appointment.

Museum still bear Walker's handwriting on their labels—a memorial to the strong bonds that existed between eighteenth-century mineralogy and patronage.[160]

In addition to the Hope family, Walker was able to procure his specimens from a variety of other sources. The most immediate was his own backyard. Since this was a time when physicians and apothecaries still had to scour the countryside for pharmacological simples, his training at Edinburgh's Medical School and with Cullen proved to be very useful because it had taught him how to utilise the specimens that existed in his own locality. Walker's list of 'fossil' suppliers also shows that foreign minerals also played an important role for his mineralogical investigations. For the Edinburgh community, Baltic sources were just as important as those that came from the Mediterranean and, to a lesser extent, the Americas. Such a wide variety of locations suggests that Scottish mineralogy, like botany, benefited from Britain's central position in eighteenth-century trade and colonisation. The emphasis placed upon mineralogical topics in the Medical School led many of the physicians and surgeons assigned to naval or diplomatic posts to be on the lookout for foreign fossils. A good example of this practice is Dr. John Rogerson and the samples that he sent to Walker from St. Petersburg. The efforts of such mineralising physicians were often reinforced by the patronage of Scottish ambassadors who owned mines and who wanted to compare their ores to those of foreign countries. It was probably for this reason that Lord Cathcart, the British Ambassador to Russia, collected ores and gave patronage to physicians like Rogerson. Another diplomat interested in mineralogy was Robert Liston, the ambassador to Spain. He used his influence to acquire and send Walker several different types of ores during the 1780s. The reasons for supplying foreign minerals were therefore complex and the cases of these physicians and diplomats, or even that of Da Costa and Walker, force the researcher to consider the motivations of those who participated in the mineralogical trade. Were minerals simply collected because of their novelty, or were they initially selected to be compared chemically to indigenous ores and pharmaceutical simples that could be commodified?

To answer this question, more work will have to be done on the eighteenth-century mineralogical scene in Britain. Not just for Scotland, but also for England, Ireland and Wales. Not only do the practising mineralogists need to be more clearly identified, but the sources that were used as field guides and in university medical courses also need to be surveyed. One good source that can be used for ascertaining

[160] There were over one hundred of these marble specimens, many of which are housed in the National Museum of Scotland,

the Scottish mineralogical canon is Walker himself. The wide range of manuscripts that he left behind gives a clear picture of the sources, method and vocabulary that he used when creating the mineralogical classification system that he taught his students during the 1780s and the 1790s. It is therefore one of the goals of the next chapter to address this facet of his mineralogy. This will in turn lay the foundation for Chapter 5's detailed treatment of his chemical-mineralogical system.

reference number, G1993.34.

Chapter 4

The Sources & Vocabulary of Mineralogy

Introduction

In 1779 Walker was appointed by the Edinburgh town council to be the University's second Professor of Natural History. At the time, he was the minister of Moffat and it took him three years to secure a parish within the vicinity of Edinburgh. In July of 1782 the Earl of Lauderdale officially presented him the parish of Colinton, which was only a few miles to the southwest of the city.[1] Relocating to the Edinburgh area allowed Walker to commence with lecturing in the autumn of 1782. During the next two decades he would correspond with leading naturalists[2] and teach over seven hundred students, many of whom would go on to influential careers in the natural sciences.[3] Additionally, his position within the University allowed him to obtain several more aristocratic patrons who sought to apply his mineralogical knowledge to soil management and mineral prospecting. To date there has been no work done on the mineralogical content of his lectures, correspondence or his participation with the academic societies of Edinburgh. More importantly, the actual structure of the mineralogical system that he taught to his students has never been examined. The next two chapters seek to alleviate this problem. Chapter 4's primary goal is to excavate the mineralogical sources and vocabulary that laid the foundation for his mineralogical studies. Chapter 5 then builds on this by investigating how he actually constructed his mineralogical classification system.

The primary sources for this chapter and the one that follows are lecture notes taken by students, the various printed versions of the natural history course's syllabus, a printed catalogue of Walker's library and manuscripts written by Walker himself. As many of the words and terms that he used have received little attention from earth science historians, Section I of the present chapter explains the

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* This chapter is based on my forthcoming publication: 'The Medical Language of Mineralogy in Eighteenth-Century Scotland' in David Knight and M. D. Eddy (eds), *Science and Beliefs: From Natural Philosophy to Natural Science, 1700-1900* (forthcoming: 2004). Many thanks to following people for their comments on the content and/or sources of this chapter: D. M. Knight, D. R. Oldroyd, Hjalmar Fors, Staffan Müller-Wille, Andreas-Holger Maehle, Michael Barfoot, Robert Fox, William A. Kelly and the NAHSTE project and the University libraries of Durham, Newcastle and Edinburgh. I would also like to thank the participants of the following conference who commented on the last section of this chapter: 'Science & Beliefs: from Natural Philosophy to Natural Science, 1700-1900', St. John's College, University of Durham, 12-13 September 2002.

[1] 8 July 1782. Presentation of the Earl of Lauderdale in favour of Doctor John Walker, EUL La.III.352/1 f. 54.

[2] See Appendix V.

[3] See Appendices IV and VI.

historiographical difficulties that emerge when one attempts to study the vocabulary and reading material that was available to an eighteenth-century mineralogist like Walker. Building on this, Section II identifies the books that made up the core of his mineralogical canon. It mainly shows that he valued sources that were based on the 'principles' and forms of analysis associated with five-principle chemistry. This discussion leads into Section III where the vocabulary that Walker used to classify minerals is addressed. From this discussion it will be seen that the sources and vocabulary of eighteenth-century taxonomy were multifaceted. There were many competing systems and Walker navigated his way through this context by applying the empirical mindset taught to him by Cullen and other members of Edinburgh's Medical School.

I. Historiographical Concerns

Historiographical Concerns

Before I address Walker's sources and vocabulary, a brief word must be paid to a few background historiographical issues. Aside from the books and articles written by Rachel Laudan and David Oldroyd, virtually no work has been done on examining the origin and nuanced usage of the vocabulary that governed the multitude of mineralogical systems that sprang up throughout Europe in the eighteenth century. Indeed, many treat the names offered by Linnæus as an epistemological terminus and do not explore the nomenclatural language employed by his rivals. Because so many Linnæan terms became the canon for later (and current) natural historians, it is assumed that Enlightenment naturalists followed relatively the same definitions that were laid out in *Systema Naturæ*. Yet, even the simplest inquiry into the vocabulary employed by post-Linnæan mineralogical systems reveals that these terms, and a wealth of others that Linnæus did not use, were by no means settled. Even if there was a consensus on Latin definitions (which there was not), the transfer of classificatory terms into the vernacular often came down to the preference of the individual author. The situation becomes even more complex when one introduces mineralogies that preferred to use artificial (chemical) characters (as opposed to the natural characters of Linnæus) because these systems fell victim to definitional problems so aptly discussed by Maurice Crosland in *Historical studies in the language of chemistry.* Unfortunately this linguistic predicament of mineralogy has not attracted very much attention from scholars and a book that addresses the vocabulary (chemical and natural) of early modern mineral systems has yet to be written.

On the surface, these unclarities may seem simply academic and confined to those mineralogists who had the spare time to write their own systems. However, no matter if a mineralogist used chemical (artificial) or natural characters, mineralogical classification played an important role in many areas of enquiry. It allowed rural physicians to arrange their local mineralogical simples so that they could use pharmacopoeia recipes to make 'cures' for stomach-aches, diarrhoea and the stone. Similarly, professors of *materia medica* used mineralogical systems to order the data acquired from experiments which used or produced 'fossil-like' simples. These systems in turn played a strong role in determining the therapeutic potential of a medicinal well. The arrangement of minerals touched upon economic issues. Land owners who had large mines sometimes used chemical composition of minerals to prognosticate the location of metallic veins and naturalists scoured the countryside looking for the perfect specimen of an order or a class to supplement their own collections. Industrialists used saline analysis in hopes to find new alkalis that could aid in the bleaching process. This list could go on, but the point is that all these people needed a way to organise the vast array of minerals that existed in their own local area and which they acquired from abroad.

In a recent article, Patrick N. Wyse Jackson noted: 'Correct understanding of early geological printed works and manuscripts can be difficult to achieve when lithological and mineralogical terminology unfamiliar to the reader is used. This is a prevalent problem in early texts when mineralogical and lithological names had not become standardized.'[4] Walker's Edinburgh context was not immune to this diagnosis—a case particularly relevant to earth science historians because the final written form of his system also doubled as the catalogue for the mineralogical collection in Edinburgh's Natural History Museum. Since a sustained treatment of individual eighteenth-century mineralogical systems is simply not feasible at present (for Scotland, or even for Europe),[5] it is the intent of this chapter to use John Walker as a case study that seeks to further understand the sources and vocabulary that were used to classify minerals in Edinburgh. As he taught over 700 students and corresponded with some of the most well known naturalists of the eighteenth

[4] P. N. W. Jackson, 'Geological Museums and their Collections: Rich Sources for Historians of Geology', *AS*, **56** (1999), 426.
[5] See A. Livingstone's *Minerals of Scotland: Past and present* (Edinburgh: 2002).

century, such a study will be relevant to other parts of Britain, Europe and the Americas.

Images of Walker

Another issue that has affected the study of Walker's sources and vocabulary is the negative, or perhaps incomplete, image given to him by past historians. During his time Walker was seen as an influential Edinburgh figure. One of the classic sources for late eighteenth-century Scottish history is Hugo Arnot's *A History of Edinburgh* (1816). Of all the academic biographies given for each member of the Medical School, John Walker's is the largest. As a figure that merited such attention, it is surprising to note that there are only a few published sources that can aid in ascertaining the content of Walker's mineralogical classification system.[6] During the nineteenth century, Robert Jameson (1820)[7] and the *Edinburgh philosophical journal* (1822)[8] published truncated excerpts of his mineralogy lecture notes and manuscripts. After the 1820s, scholarly interest in Walker's work soon faded. This ignominy was influenced by the rising popularity of physical geology and by the fact that his work was often seen in light of Robert Jameson's Wenerianism and cronyism. There are a few anecdotal references to Walker scattered throughout nineteenth-century histories, especially in biographies of Jameson and histories of botany. But on the whole, his work did not receive renewed attention until the 1950s when Scottish historians began to emphasise the differences between England and Scotland's intellectual history. This led to Walker's work being flagged by James Ritchie, George Taylor and James Kendall.[9] However, none of them directly addressed his mineralogy.

Such attention led the geologist Harold W. Scott to edit selections of student notes taken from Walker's natural history lectures. Published in 1966 as *Lectures in Geology*, this book shapes how most historians of science currently perceive Walker's later mineralogy and geology. Indeed, it is cited in the seminal works of

[6] Outside of library catalogues, secondary sources that treat eighteenth-century 'scientific' texts are few, especially for books that address five-principle chemistry and non-Linnæan taxonomy. One helpful overview of this time period is B. J. Ford's 'Eighteenth-century Scientific Publishing', in Andrew Hunger (ed), *Scientific books, libraries, and collectors*, (Aldershot: 2000), 216-257.

[7] R. Jameson includes a copy of Walker's 1787 *Classes fossillium* in: *A system of mineralogy*... (Edinburgh: 1820), xxxiii-xxiv.

[8] John Walker, '*Notice of Mineralogical Journeys, and of a Mineralogical System*, by the late Rev. Dr. John Walker, Professor of Natural History in the University of Edinburgh', *EPJ*, **6** (1822), 88-95.

[9] James Ritchie, 'Natural History and the Emergence of Geology in the Scottish Universities', *TEGS*, **15** (1952) 297-316. George Taylor, 'John Walker, D.D., F.R.S.E. 1731-1803. Notable Scottish Naturalist', *TBSE*, **38** (1959), 180-203. James Kendall, 'The First Chemical Society, the First Chemical Journal, and the Chemical Revolution, Parts I and II', *PRSE*, **63A** (1952), 346-358, 384-400.

Roy Porter, Gordon L. Herries Davies and V. A. Eyles.[10] Even though Scott's edition is a useful source for gaining an introductory understanding of Walker's work, the selection of the material was influenced by Scott's desire to prove that Walker was the 'father of Scottish geology'. Scott's geological spyglass is especially apparent in his treatment of Walker's mineralogy and this presents two significant difficulties. The first is the book's actual content. Walker divided his lectures into two sections: Hippocratean (meteorology, hydrography and geology) and the Empire of Nature (mineralogy, botany and zoology). Because of his interest in physical geology, Scott ignores Walker's chemical conception of stones and rocks. Furthermore, even though Walker gave more lectures on mineralogy than any other subject, Scott only includes one of these lectures in his collection. To the average reader, such a selection implicitly suggests that Walker was more interested in physical geography than chemical mineralogy. This situation is further complicated by the fact that Scott's introduction, annotations and bibliography do not treat the foundational role played by chemistry in Walker's approach to the subject.

A second problem is Scott's arrangement of the text. As we shall soon see, at least eleven complete copies of Walker's notes exist in various Scottish libraries. Even though they were written at different points over a twenty-year period, Scott essentially cut and pasted bits and pieces from all these manuscripts to create one text. This leaves the discerning reader to wonder which text is being read at any given point and whether or not Walker consistently used the same sources and vocabulary. To be fair, since Walker's method of arrangement remained relatively consistent during this period, (some of his classifications did change), Scott's approach is useful for gaining a general understanding of Walker's Hippocratean lectures (especially in regard to terminology that would be used later in the nineteenth century). However, any detailed analysis based upon Scott's edition is limited because he often does not give archival references for several sections of the text. This makes it difficult to match Scott's text to the original notes taken by Walker's students. Additionally, Scott also included printed material (published posthumously) that was not originally part of Walker's lectures and dismissed many of Walker's ideas and sources that did not conform to his modern (twentieth century) conception of the earth sciences.

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[10] Roy Porter, *The making of geology* (CUP: 1977), 112, 144, 149, 151, 153-55, 165, 170-71, 233-34; G. L. H. Davies, *The Earth in Decay* (London: 1969), 105-106, 112, 123, 125, 147. V. A. Eyles, 'The Extent of Geological Knowledge in the Eighteenth Century, and the Methods by Which It Was Diffused', in Cecil J. Schneer (ed), *Toward a history of geology* (London: 1969), 159-183, esp. 180-81.

II. Sources for Mineralogy

Notes, Catalogues and Nature

Aside from Scott's work, there are two major sources that can be used to ascertain the various influences that shaped Walker's mineralogy from the 1780s to 1800: the aforementioned student lecture notes and the catalogue of his personal library. I shall first discuss the former. As mentioned in the introduction of this chapter, Walker taught over seven hundred students during his tenure as Professor of Natural History. Many of them compiled their lecture notes into bound volumes and some went as far to have them rewritten by a professional stenographer. In total, there are no less than eleven of these bound editions.[11] None of these works were ever committed to print. The first set of extant manuscript notes are the incomplete 1782 collection taken by Francis Morison.[12] The next set is Thomas Hope's 1784 *Lectures on Natural History.*[13] After these notes, there are sets from (*circa*) 1789,[14] 1790[15] and 1791.[16] The most aesthetically pleasing and easiest to read are the stenographed volumes of [Sir] David Pollock's *An Epitome of Natural History* (1797).[17] However, by the time these notes were taken, Walker had stopped lecturing on botany.[18] Pollock's notes are especially helpful because they give an extensive reading list (often including the author, book and page numbers) for each mineralogical class and order. These references were most probably obtained directly from Walker because he had a list of 'Synonimia of Authors, and incidental observations' that he gave only to students who attended his lectures.[19]

Walker died on 22 January 1803. On 14 May of the next year, the book dealer Cornelius Elliot auctioned his library. For the event, Elliot compiled *A Catalogue of the Books in Natural History with a Few Others, which Belonged to the*

[11] Nine of them are housed in Edinburgh University's library (EUL), one in the library of Edinburgh's Royal College of Surgeons and one in the special collections of the University of Aberdeeen.
[12] Francis Morison (transcriber), *Lectures on natural history (1782)*, 8 vols. Royal College of Physicians Special Collections. Wanting vols. 5, 6 and 7.
[13] [Anon.] (transcriber) *Lectures on natural history*, EUL Bound MS DC.2.22. These were not stenographed and are therefore quite hard to read. Thomas Charles Hope (transcriber), *Lectures on natural history 1784*, EUL Bound MS DC.10.15$^{1-5}$.
[14] Most probably taken by T. Birch (transcriber), *Notes and lectures on natural history Vols. I – IV*, EUL Bound MS Gen. 50-53.
[15] [Anon.] (transcriber), *Lectures on natural history 1790*, EUL Bound MS, DC.2.23-28. [Anon.] (transcriber), *Notes of Dr. Walker's lectures of natural history*, EUL Bound MS, DC.10.33.
[16] John Douglas (transcriber), *Notes of Dr. Walker's lectures on natural history*, EUL Bound MS, DC.8.31. [Anon.] (transcriber), *Lectures on natural history Vols. I – III*, EUL Bound Ms, 7.113$^{1-3}$ – these are rather truncated.
[17] David Pollock (transcriber), *An epitome of natural history 1797 Vols. I – XII*, EUL Bound MS, 703.D-712D.
[18] 'On the Subject of Botany, we proposed to consider, Vegetable Anatomy, Vegetable Physiology, and Vegetable Economy, but as this Subject has a different Course allotted to it, we shall not treat it here.' *An epitome of natural history Vol. IX* (1797) EUL Gen 711.D, f. 121.
[19] John Walker, *Systema fossilium*, Bound MS, Glasgow University Library (subsequently GUL) GB 247, MS Gen 1061 (1795 Watermark), f. 24.

Late Rev. Dr. Walker (Plate 4.I).[20] The only known copy of this is housed in the Walker Collection at the University of Edinburgh. The list consists of 582 titles. It is by no means comprehensive, but it does serve to identify the works that Walker valued enough to purchase. This is important because, as was mentioned in Chapter 1, Walker considered himself the primary repository of natural history books in Edinburgh. He even took care to stress this point to the Edinburgh Town Council around 1781 when he was attempting to raise his salary.[21] Even though several of Edinburgh's libraries contained works on natural history (indeed, he even owned an incomplete copy of the Judge Advocate Library catalogue), his lectures most often emphasised the books that were in his own collection. When combined with the references cited in his lectures, Elliot's *Catalogue* and Walker's own *Index Librorum*[22] can be used to identify the majority of Walker's sources—often right down to the specific edition. Aside from shedding light on the works that Walker personally valued, this also gives a helpful picture of the sources that he was presenting to his students.[23] This is significant, because as Oldroyd and Laudan have shown,[24] there were a plethora of mineralogical works available during the eighteenth century.

In addition to the published sources mentioned in his lectures and the *Catalogue*, Walker also used a significant number of 'fossils' to illustrate physical and chemical characters that he had discovered on his own, or which were present in the various mineralogies he was citing. In fact, all the student mineralogy notes are replete with references to specimens that he used during his lectures to illustrate a given species. Pollock recorded the following when Walker was discussing metals: 'Here were produced some Specimens of the Ores of Iron, Copper & Lead.'[25] Sometimes, chemical experiments were either suggested or performed during the lecture. For instance, Pollock noted the following during Walker's discussion of the second genus of Gypsum: 'They are well known by the Name Blue John. Of this there was a Specimen of various Colours, and if placed on hot Coal, each Colour would throw out a Phosphorescent Light of its own.'[26] Since Walker was the Keeper

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[20] C. Elliot, *A Catalogue of the books in natural history with a few others, which belonged to the late Rev. Dr. Walker, Professor of Natural History in the University of Edinburgh* (Edinburgh: 1804), EUL La.III.352/6. As stated in Chapter 1, the abbreviation 'EC' followed by a number will be used in this thesis to show where a particular book is located in Elliot's catalogue.

[21] John Walker to Edinburgh Town Council [c.1786], EUL La.III 352/2 ff. 7-8.

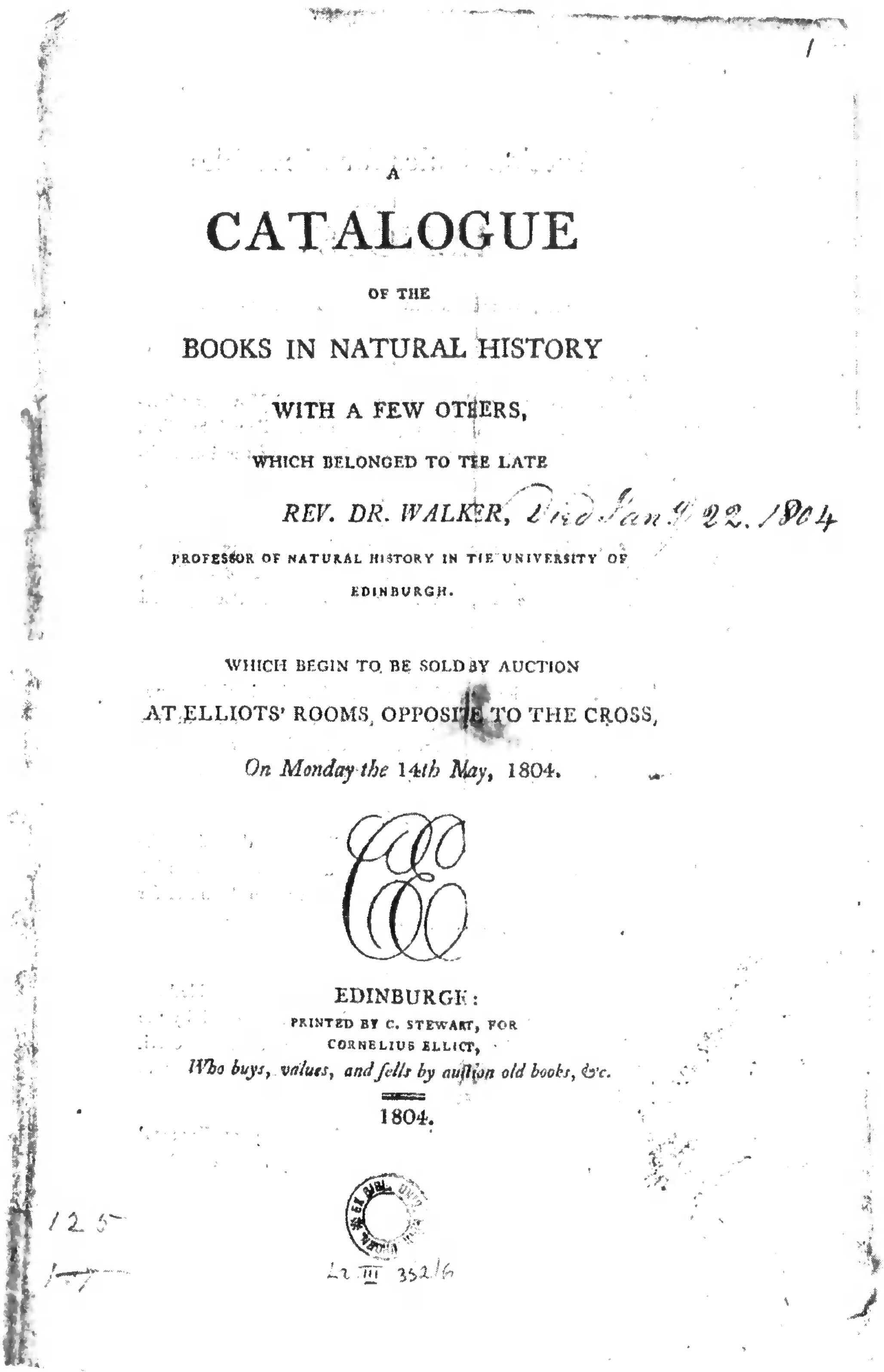
[22] This source is the list that Walker himself made of his own library in 1761. It is treated in more detail in Chapter 2.

[23] Throughout the footnotes of the following chapters I will use the letters 'EC' to denote 'Elliot's Catalogue'. Thus, the appellation 'EC 20' means that the work is listed as number twenty in the catalogues numerical system. These catalogue references will always follow the date of a given book or article.

[24] R. Laudan, *From mineralogy to geology* (London: 1987). D. R. Oldroyd, *Sciences of the earth* (Aldershot: 1998).

[25] Pollock, (1797) *An epitome of natural history Vol. VII*, EUL Gen. 709D f. 167.

[26] Pollock (1797), *An epitome of natural history Vol IV*, EUL Gen. 706D f. 30.



A

CATALOGUE

OF THE

BOOKS IN NATURAL HISTORY

WITH A FEW OTHERS,

WHICH BELONGED TO THE LATE

REV. DR. WALKER, Died Jan.y 22. 1804

PROFESSOR OF NATURAL HISTORY IN THE UNIVERSITY OF EDINBURGH.

WHICH BEGIN TO BE SOLD BY AUCTION

AT ELLIOTS' ROOMS, OPPOSITE TO THE CROSS,

On Monday the 14th May, 1804.

EDINBURGH:

PRINTED BY C. STEWART, FOR

CORNELIUS ELLIOT,

Who buys, values, and sells by auction old books, &c.

1804.

Elliot's Catalogue of Walker's Library
Edinburgh University Library
La.III.352/6

Using this catalogue and the student lecture notes taken in Walker's course, it is possible to determine the exact editions of the books that shaped his mineralogical canon.

of the Natural History Museum and had friends who had their own collections (Joseph Black for example), he had access to quite a number of fossil specimens. As was mentioned in Chapter 3, several of these specimens still exist today and are currently housed in the National Museum of Scotland.

Even more abundant than museum samples were the crags, peaks and hills of the Lothians. Because of their availability, Walker took care to mention mineralogical specimens in the area immediate to Edinburgh. He did this because the area around the city was mineralogically diverse. The summits of Salisbury Crag and Arthur's Seat could be seen from the city and could be reached after about a sixty-minute walk on foot – although there was also much to see on at their bases (a fact currently highlighted by a plaque to James Hutton at the bottom of Salisbury Crag). To direct his students' steps in such a theatre of nature, Walker told them where to go and what to look for. He did this by mentioning locations in his lectures and by giving them an explicit guide entitled 'Names and Descriptions of all the Fossils in the Neighbourhood of Edinburgh'.[27] For instance, when discussing *maltha psadurii* (mountain tar), he states: 'It is found in the Lime stone, at Lord Elgin's Quarries, at Charleston, on the opposite Shore of the Forth.'[28] Such directions allowed his lectures to work in conversation with the landscape of Edinburgh (and even the whole of Scotland). It also allowed his students to gather different types of minerals that were held to have different pharmacological qualities based on their geographic origin.[29] A large percentage of the sites mentioned in Walker's lectures are still accessible today.[30]

An 'Atypical' Canon?

As Pozzo and Oberhausen have recently noted, there is a lack of studies which treat the production and use of textbooks in the Enlightenment.[31] At face value, Walker's mineralogical canon appears to be 'atypical' from that which is often presented in secondary histories of the earth sciences. But, if one looks at the works that are cited in the *Philosophical Transactions*, medical lectures in other European

[27] Pollock (1797), *An epitome of natural history Vol. IX*, EUL Gen. 711D, ff. 11-40.

[28] Pollock (1797), *An epitome of natural history Vol. IX*, EUL Gen. 711D, f. 25.

[29] A good example of this type of simple was the limestone. It was used to make the limewater solution that was used for treating bladder stones. This is briefly treated in M. D. Eddy, 'Medicine, Commodification and Exploration in Enlightenment Scotland', The History of Science Society's 2002 Annual Meeting (7-10 November), Milwaukee, Wisconsin.

[30] For the importance of 'locality' in geological history, especially for Walker's contemporary James Hutton, see D. R. Oldroyd, 'Non-written Sources in the Study of the History of Geology: Pros and Cons, in Light of the Views of Collingwood and Foucault', *AS*, **56** (1999), 395-415.

[31] R. Pozzo and M. Oberhausen, 'The place of science in Kant's university', *HS*, **40** (2002), 353-368. Since the term 'textbook' is a modern idea, I use it rather loosely to imply a book which was recommended by a professor or which students found helpful. J. H. Brooke has made similar observations about pre-Lavoisierian chemistry textbooks. See his introduction to A. Lundgren and B. Bensuade-Vincent. *Communicating chemistry* (Canton: 2000).

medical schools and in the very sources that Walker was reading, it soon becomes apparent that his 'atypical' canon was actually quite typical. Based on the books that methodologically influenced his system and on those which he cited in his lectures, it can be seen that his mineralogical canon consisted of about a dozen key works and about fifty more of secondary importance.[32] In the analysis that follows, I will cite the book editions that are listed in Elliot's *Catalogue*.[33] Most of the core books of the canon employed a significant amount of chemistry. As demonstrated in the previous chapters, Walker had been introduced to many chemists via Cullen and his own study during the 1750s and 1760s. Walker transferred many of these sources directly into his own canon:[34] Johann Heinrich Pott, Georg Ernst Stahl, Johann Becher, Johann Friedrich Henckel, Andreas Marggraf, Johann Friedrich Cartheuser and Herman Boerhaave.[35] Of these, Henckel and Stahl are listed on his 1761 *Index Librorum*.[36]

Walker's familiarity with Cullen's canon led him to collect mineralogical systems that were based upon chemistry. Two of these, Valmont de Bomare and Axel Fredrik Cronstedt,[37] were mentioned in the last chapter. In addition to Cronstedt's *Mineralogy*, Walker also owned a copy of an 'Appendix to Cronstedt's Mineralogy', which is most probably the one given to him by Cullen when he went on his first trip to the Hebrides.[38] Even though all the above authors played an important role in informing the mineralogy that Walker taught his students, the mineralogical systems that most influenced his university lectures were those of Johan Gottschalk Wallerius, Torbern Bergman and Richard Kirwan (Plate 4.II).[39] Of

[32] Elliot's catalogue will be represented as 'EC' in the footnotes that follow in the rest of this thesis. Many of the works listed in it are addressed in the five volumes of W. A. S. Sarjeant, *Geologists and the history of geology: An international bibliography from the origins to 1978 vols. I – V* (London: 1980). However, since the chemical component of geology is undervalued in these volumes, many of the sources used by Walker and his Scottish contemporaries are not present).

[33] Elliot's catalogue sometimes can be confusing because he only lists a shortened version of each book's title and because he sometimes confuses the author's name with that of the translator. As he does not list the publisher, I will only list the date and place of publication. The full details of the books that follow are taken from library catalogues in the UK, Sweden, France, Germany and the United States.

[34] For a list of authors being used by Cullen in the chemistry lectures that he gave during the 1750s, see Appendix II.

[35] J. H. Pott, *Observationum et animadversionum chymicarum* ... (Beroli: 1739) EC 250; *Dissertations chymiques*... (Paris: 1759) EC 483: G. E. Stahl, *Fundamenta Chemiæ* (Norimbergae: 1723). No. 525 EC 27; *Georgii Ernesti Stahlii Fundamenta chymiae*... . (Norimbergae: 1747) EC 343: J. J. Becher, *Institutiones chimicæ prodromæ*... (Amstelodami: 1664). EC 373: J. F. Henckel, *Pyritolgia: or, A history of the pyrites, the principal body in the mineral kingdom*... (London: 1757) EC 97. A. Marggraf, *Opuscules chymiques* (Paris: 1762). EC 374; J. F. Cartheuser, *Elementa chymiae*... (Frankfort-on-Oder: 1753) EC 483: The only book by Boerhaave listed in the *Catalogue* is *Historia plantarum*... (Romae: 1727).The influence of Boerhaave's chemistry so saturated the Edinburgh medical community that Walker probably did not need to own his own copy of *Elements of chemistry*.

[36] John Walker, *Index Librorum (1761)*, EUL DC.2.38 Bound MS, IL 120 and 121.

[37] J. C. V. de Bomare, *Mineralogie, ou nouvelle exposition du regne minéral*... (Paris: 1762). EC 121: A. F. Cronstedt, *An essay towards a system of mineralogy*, G. Engestrom (trans) & E. M. da Costa (ed) (London: 1770) EC 407; *An essay towards a system of mineralogy*... G. Engestrom & J. H. Magellan (trans), (London: 1788) EC 408.

[38] 'Appendix to Cronstedt's Mineralogy', EC 468.

[39] J. G. Wallerius, *D.D. Lucubrationum academicarum specimen primum de systematibus mineralogicis et systemate mineralogico rite condendo* (Holmiæ: 1768) EC No. 5, 1; *Mineralogie, ou description générale des substances du regne mineral*... 8 vo. (Paris: 1753) EC No. 117, 4; *Elementa metallurgiae speciatim chemicae conscripta atque observationibus*... (Holmiae: 1768) EC No. 122; *Chemiae physicae pars prima, de chemiae natura ac indole in genere ejusdemque historia*...(Stockholm: 1760) EC 320; *Systema mineralogicum* 2. tom. (Holmiae: 1772) EC 401: T. Bergman, *Physical and chemical essays* (London: 1784) EC 92, 4 (Since both Thomas Beddoes and William Cullen issued translations of this text in

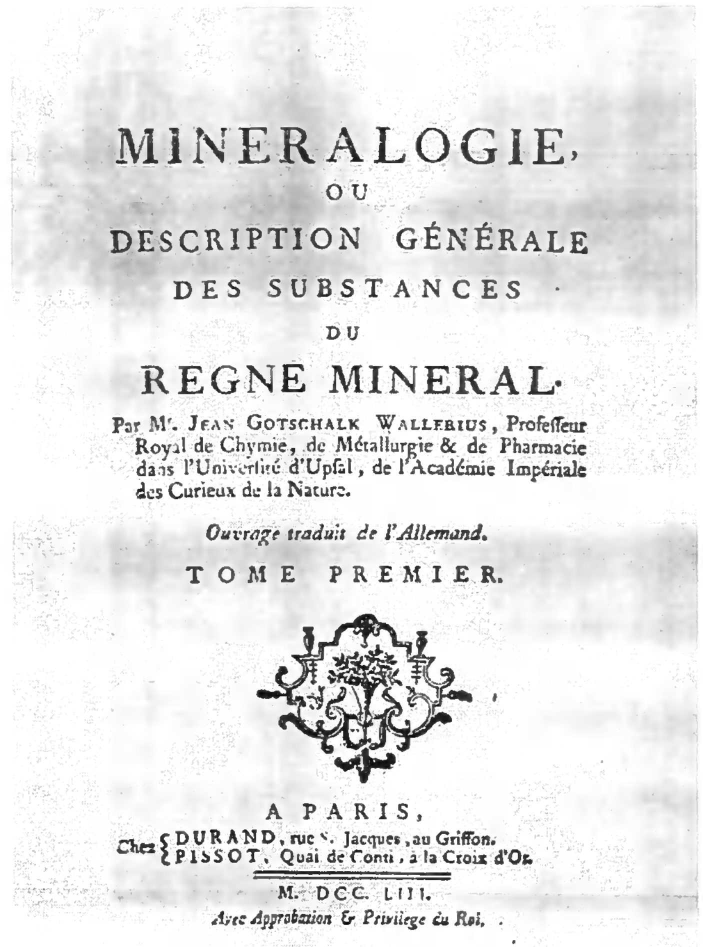
Joh. Gottschalk Wallerius,
Der Weltweisheit und Arzneikunst Doktors auf der königl. Akademie zu Upsala, der medicinischen Facultät Adiunctus, der römisch-kaiserlichen Akademie der Naturforscher, auch des königl. medicinischen Collegii zu Stockholm Mitgliedes,

Mineralogie,
oder
Mineralreich,
von Ihm eingeteilt und beschrieben.

Ins
Deutsche übersetzt
von
Johann Daniel Denso,
Königlichen Professore am Collegio Gröningiano zu Stargard in Pommern, Conrectore an der Stadtschule, der königl. deutschen Gesellschaft zu Königsberg, auch der zu Leipzig Mitgliede.

Berlin,
Verlegts Christoph Gottlieb NICOLAI
1750.

J. G. Wallerius, *Mineralogie, oder Mineralreich von ihm eigeteilt und beschrieben*
(Berlin: 1750)



MINERALOGIE,
OU
DESCRIPTION GÉNÉRALE
DES SUBSTANCES
DU
REGNE MINERAL.

Par Mr. JEAN GOTSCHALK WALLERIUS, Professeur Royal de Chymie, de Métallurgie & de Pharmacie dans l'Université d'Upsal, de l'Académie Impériale des Curieux de la Nature.

Ouvrage traduit de l'Allemand.

TOME PREMIER.

A PARIS,
Chez DURAND, rue S. Jacques, au Griffon.
PISSOT, Quai de Conti, à la Croix d'Or.

M. DCC. LIII.
Avec Approbation & Privilege du Roi.

J. G. Wallerius. *Mineralogie, ou description générale des substances du regne mineral*
(Paris:1753)

Minéralogie, Wallerius' most widely read work on minerals, was never published in English. As Walker and most of Edinburgh's medical faculty read French, this did not present a problem.

Chapter 4. Plate II.

these, the sheer number of Wallerian works in the *Catalogue* demonstrate Walker's high regard for his work.[40] Indeed, he thought that Wallerius' *Systema Mineralogicum* (1760) was the most helpful book available to a beginning mineralogist: 'All that I have to say with regard to this work is that if a student is to be confined to one work it is the best.'[41] Other chemical mineralogists mentioned less frequently are, Friedrich August Cartheuser, and, later, Robert Jameson.[42]

In addition to systems based on chemical characters, Walker also consulted authors who favoured natural characters. The progenitors of this approach were Theophrastus and Pliny. Even though they are not in the *Catalogue*, Walker references *De lapidibus*[43] and *Historia naturalis* in his mineralogy and geology lectures. Of these works based on natural characters, I will only cite the ones that Walker mentions in his lectures on a frequent basis and which are listed in the *Catalogue*. The most influential in this category was Linnæus (Plate 4.III). Walker had become familiar with *Systema Naturæ* early in his career and by the time of his death he owned at least four editions of it[44] (in addition to several copies of Linnæus' other works).[45] Walker also consulted the works of John Woodward, Emanuel Mendes Da Costa, Comte de Buffon and John Hill.[46] Of these, Woodward's *Natural History of Fossils* and Hill's *General Natural History of Fossils* had been in his possession since at least 1761.[47] These systems along with the chemical mineralogies listed above formed the core of Walker's canon and correspond with the texts that were being used by other British and European mineralogists.[48] Outside of this group were about twenty other mineralogical systems that he used more sparingly. A few of the names in this peripheral group are Konrad Gesner, Johann Wilhelm Baumer, Jean Baptiste Louis de Romé de l'Isle, Lorenz Theodor

the same year, it is hard to tell which edition Walker used); *A dissertation on elective attractions by Torbern Bergmann*, Thomas Beddoes (trans), (London: 1785) EC 109; *An essay on the usefulness of chemistry...* (London: 1783) EC 328, 11; *Outlines of mineralogy*, William Withering (trans), (Birmingham: 1783) EC 131: R. Kirwan, *Elements of mineralogy*. EC gives no publication details. Most probably (London: 1784) EC 569.

40 One of the books that Walker was keen to acquire the year he was appointed to his professorship was Wallerius' *Mineralogie*. See Drummond Books to Walker, 27 April 1779, EUL La.III.352/1.

41 Walker (1966), 'Mineralogy', 226.

42 F. A. Cartheuser, *Rudimenta oryctographiae Viadrino-Francofurtanae* (Francofurti a. V. Kleyb: 1755) EC 468. R. Jameson, *Mineralogy of the Scottish isles...* (Edinburgh: 1800) EC 346.

43 Walker could have possibly been using J. Hill's version of Theophrastus: *History of stones* (London: 1746).

44 C. Linnaei, *Systema naturae...* [13th edition] (Vindobonae: 1767) EC 39; *Systema Naturæ* (2 vols.) EC 104, no publication information given; *Systema naturae; sistens regna tria naturae... Accedunt vocabula gallica* (Lugduni Batavorum: 1756) EC 110; *Systema naturae per regna tria naturae... Cura Jo. Frid. Gmelin* (Lipsiae: 1788-1793) EC 418.

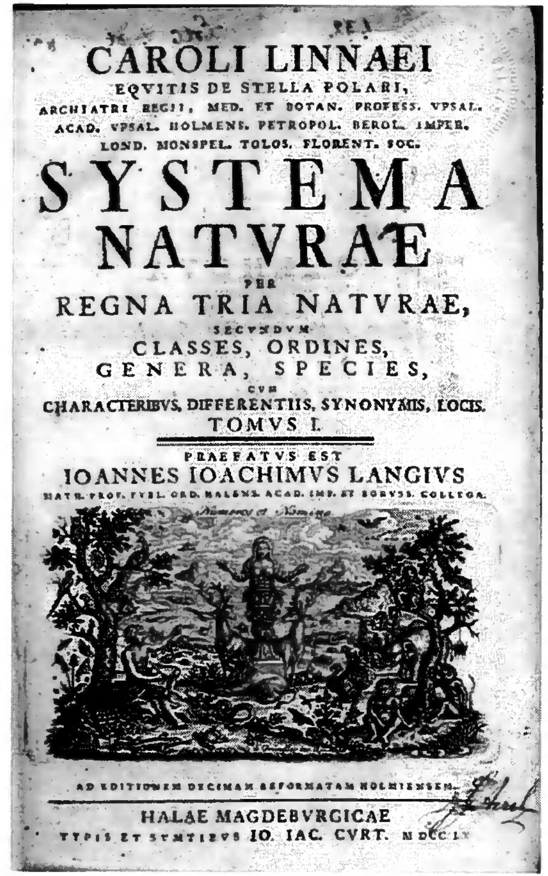
45 These mostly dealt with botany, See EC Nos. 387-90, 423, 426 and 573.

46 J. Woodward, *An attempt towards a natural history of the fossils of England...* (London: 1729) EC 43. E. M. da Costa *A natural history of fossils* (London: 1757) EC 62; This is listed again in EC 515. G. L. L., comte de Buffon, *Histoire naturelle des minéraux... Tome premie*. (Paris : 1783) EC 63; *Natural history, general and particular*, W. Smellie (trans), (Edinburgh: 1780) EC 98; *Génie de Buffon, ou Choix littéraire et scientifique des meilleurs morceaux de cet auteur, par un ecclésiastique* (Paris: 1785) EC 126. John Hill *A general natural history... of the animals, vegetables and minerals* (London: 1773) EC 86. The *Catalogue* lists the 1773 date, but I have only been able to find the 1748-52 version (in the Wellcome Library, London).

47 See *Index Librorum*, Nos. 8 and 14.

48 See Eyles (1969) 173-78 and T. Porter, 'The Promotion of Mining and the Advancement of Science: the Chemical Revolution of Mineralogy', *AS*, **38** (1981), 543-570.

Linnaeus in His Lapland Dress
Copy by Eleonora Lindstrom-Hennig, 1907, of Hollander's adaptation of Martin Hoffman's original portrait, 1737. Hunt Institute for Botanical Documentation.


CAROLI LINNAEI
EQVITIS DE STELLA POLARI,
ARCHIATRI REGII, MED. ET BOTAN. PROFESS. VPSAL.
ACAD. VPSAL. HOLMENS. PETROPOL. BEROL. IMPER.
LOND. MONSPEL. TOLOS. FLORENT. SOC.
SYSTEMA
NATVRÆ
PER
REGNA TRIA NATVRAE,
SECVNDVM
CLASSES, ORDINES,
GENERA, SPECIES,
CVM
CHARACTERIBVS, DIFFERENTIIS, SYNONYMIS, LOCIS.
TOMVS I.
PRAEFATVS EST
IOANNES IOACHIMVS LANGIVS
AD EDITIONEM DECIMAM REFORMATAM HOLMIENSEM.
HALAE MAGDEBVRGICAE
TYPIS ET SVMTIBVS IO. IAC. CVRT. MDCCLX

Systema Naturæ (1760) Tenth Edition

Like Walker, Linnaeus travelled the northern most parts of his own country to obtain specimens. Even though Walker accepted Linnaues' botanical arrangement, he did not accept the Swede's classification of animals and minerals. Like many Swedish, German and Scottish mineralogists, Walker's mineralogical system was greatly influenced by the definition and division method and favoured artificial (chemical) characters over Linnaeus's natural characters.

Gronovius, Ignaz von Born, Johann Reinhold Forster and Johann Lucas Woltersdorf.[49]

Mineralogical vocabulary in the eighteenth century was also shaped by a plethora of sources that sometimes escape the eye of the modern reader. To supplement the above books, Walker consulted travel accounts (including sea voyages) and regional geographies of Britain and Europe—although his library only contained a few books on Scottish geography (most probably because he had amassed his own mineralogy collection from his Scottish travels). His library also contained chemistry textbooks, bound journals (of various European societies), memoirs, indices of natural history museums, mining books,[50] individual studies of other areas of natural history (usually botany or zoology) and specialised works on metals and salts.[51] Walker's desire to use clearly defined words and terms also led him to consult both general and specialty dictionaries. Elliot's *Catalogue* indicates that he possessed several Latin dictionaries,[52] Abel Boyer's *Dictionnaire royal*[53] and a 1785 copy of Samuel Johnson's *A dictionary of the English language.* Additionally, he owned a copy of Thomas Nicols' *Lapidary*[54] and would have been further aided by definitions offered by natural philosophers like Linnæus, Cullen and Bergman.

A close look at all of the authors listed in the above paragraphs reveals two reoccurring trends. First, over three fourths of the authors were not British. In fact, the only British publications that Walker cites in his mineralogy lectures on a regular basis are Kirwan, Da Costa and Hill. Second, over half of the books are written in either French or Latin. In this respect, Walker's library resembles that of his mentor Cullen who maintained a collection that favoured continental sources.[55] French and Latin texts did not present a problem for Walker because he read both of these

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[49] K. Gesner, *De omni rerum fossilium genere*... (Tiguri: 1565) EC 567. J. W. Baumer, *Historia naturalis regni mineralogici ad naturæ auctum tradita* (Francofurti, 1780) EC 15. Jean Baptiste Louis de Romé de l'Isle, *Description méthodique d'une collection de minéraux* (Paris: 1773) EC 48. For Gronovius, the *Catalogue* lists the following: 'Gronovii Index lapideæ sup. (Leyden: 1750)' EC 308. This is most probably Laurentio Theodoro Gronovio, *Bibliotheca regni animalis atque lapidei, seu recensio auctorum et librorum, qui de regno animali & lapideo* ... (Lugduni Batavorum: 1760). I. Born, *Lithophylacium Bornianum* (1772-75) EC 360. J. R. Forster, *An introduction to mineralogy*... (London: 1768) EC 416; *An easy method of assaying and classing mineral substances*... (London: 1772) EC 492; *Catalogue raisonné d'une collection choisie de minéraux*... (Paris: 1783) EC 473 – I could only find a 1772 edition of this work (University of Glasgow). J. L. Woltersdorf, *Systema minerale* (Berlin: 1748).

[50] Particularly B. F. de Saint-Fond, *Minéralogie des volcans*... (Paris: 1784) EC 310; B. G. Sage, *Description méthodique du cabinet de l'École royale des Mines* (Paris: 1784) EC 311; T. Heton, *Some account of mines: and the advantages of them to this kingdom*... (London: 1707) EC 312; J. Pettus, *Fodinae regales, or, The history, laws and places of the chief mines and mineral works in England, Wales, and the English Pale in Ireland*... (London: 1670) EC 555.

[51] Walker's views on salts and metals will be treated in more detail in Chapter 5.

[52] R. Ainsworth, *Thesaurus linguæ latinæ compendiarius*..., (London: 1752) EC 361. T. Ruddiman's *The rudiments of the Latin tongue*..., (Edinburgh: 1790) EC 318. B. Hederich, *M. Benj. Hederici Lexicon manuale graecum*..., (London: 1739) EC 431.

[53] A. Boyer, *Dictionaire royal, françois-anglois et anglois-françois*... (Amsterdam: 1719) EC 430.

[54] T. Nicols, *Gemmarius fidelius, or the Faithful Lapidary* (London: 1659) EC 540.

[55] Cullen's personal library catalogue is briefly mentioned in A. Doig, J. P. S. Ferguson, I. A. Milne and R. Passmore, *William Cullen and the eighteenth century medical world* (EUL: 1993), 35.

languages. As there was a British market for translating foreign natural history texts at this time, several publishers in Edinburgh and London produced either a Latin or an English version of works that had been previously written in German, Swedish or Dutch (and sometimes Italian). French works were often left untranslated because it was assumed that most natural philosophers should be able to read them. This was the case for Wallerius, Walker's favourite source. Because it existed in French and Latin, an English translation was never made. In general, even though he did read Latin and French (and possibly German),[56] Walker did his best to obtain an English translation if it existed.

The Complexity of Syllabi

The first mineralogical syllabus booklet that Walker distributed to his students was *Schediasma fossilium* (1781). This was basically the heads of his newly created mineral classification system. During the same year *Delineatio Fossilium* was printed and it was meant to clarify mineralogical terms. A copy of this is not extant, but its contents can be reconstructed based on lectures where his students copied out the terms and definitions.[57] It was most probably this list of terms that he distributed to his students at the beginning of his mineralogy lectures. Sometime during the early 1780s, he also compiled a set of aphorisms for them and printed them under the title *Elementa Mineralogio.* This manuscript was modelled on Linnæus' *Philosophia botanica.*[58] It is only briefly mentioned in his later notes and this makes it hard to know how much his definitions resembled those of Linnæus. Of all these works, *Schediasma* probably had the most influence over his students during the early 1780s. As mentioned in Chapter 1, a complete printed copy of the syllabus does exist. Entitled *Institutes of Natural History*,[59] it was published in 1792 and fits within Edinburgh's professoriate's occasional proclivity to publish the heads of their lectures. *Institutes* presented a revised form of his system and the students used it to follow along with his lectures

[56] Walker's manuscript notes make several references to German journals: See 'Beilage zu den neuen Litterarische Nachrichten für Aerzte und Naturforsher 1786', EUL Dc.1.58, f. 24; 'Characters of German Writers' EUL Dc.1.58, f. 25; Neue Litterarishe Nachrichten für Aertzte und Natureforsher aufs Jahr 1785 und 1786', EUL Dc.1.58, f. 22. His library also contained a copy of a 'German New Testament' that was published (curiously) at Edinburgh in 1763. See EC 199.

[57] Scott (Walker: 1966), included some of these (taken from EUL DC.2.18) at the end of his book, 237-252. However, this only includes physical definitions and omits Walker's chemical definitions. See also Pollock's first volume on mineralogy, (1797), *An epitome of natural history Vol. VII*, EUL Gen 709D, and [Anon.], *Notes of Dr. Walker's lectures of natural history*, DC.10.33.

[58] Carl Linnæus, *Philosophia botanica*... (Stockholmiae: 1751) EC 390.

[59] See John Walker, *Institutes of natural history; Containing the heads of lectures in natural history; Delivered by Dr. John Walker, in the University of Edinburgh* (Edinburgh: 1792). The only known copy housed in Glasgow University Library, Sp Coll RB 2900. The title is very similar to William Cullen's, *Institutions of medicine*... (Edinburgh: 1785) EUL E.B. .612 Cul.

Walker's approach to printed syllabi and study aids was to simply list the terms or classification head without any other explicatory information. There were three reasons for these skeletal publications. Firstly, it forced the students to attend lectures. This allowed Walker to amend definitions without having to commit them to print. To supplement such verbal definitions, Walker also used specimens, as noted by an anonymous student around 1790: 'Technical terms in Mineralogy defined {vide syllabus} & exemplified by Specimens.'[60] Making the lecture the only place where samples could be seen and where definitions could be heard drove up class attendance and ensured that each student paid his fees when they were collected before each lecture. Second, a skeletal syllabus was shorter than a full one. This reduced the cost of publication and thereby allowed economically disadvantaged students to buy it. Third, there was a standing tradition in Edinburgh for publishing only the outlines of the lectures.[61] Even though these three reasons make it easier to understand the skeletal format of the syllabi, it also means that there are not printed sources that contain the definitions of Walker's mineralogical vocabulary. In such a situation, the only option available is to consult the student notebooks and the sources listed in Walker's own library.

When these notebooks are consulted, the situation becomes even more complex because Walker effectively forged his own definitions out of the books that he read and the experiments that he conducted on his own. These sources also make it apparent that he accepted Linnæus' definition and division methodology, but firmly rejected the Swede's natural system of minerals. This harkens back to Chapter 3's discussion of Walker's selective use of, and subsequent disagreement with, various aspects of Linnæus' work during the 1760s. Walker clearly felt no obligation to adopt all of the ideas of an author that he respected and in this he was influenced by a British context that only applied Linnaean vocabulary when it served the purposes of individual and community based approaches to mineralogical dialogue. Such a mix and match approach to vocabulary occurred in all areas of natural history. For instance, Linnæus' botanical nomenclature had been reconfigured and challenged by the alternate systems of Charles Alston,[62] John Hill[63]

[60] [Anon.] (transcriber), *Notes of Dr. Walker's lectures of natural history*, DC.10.33, f. 328. This was also practiced by D. E. Clark, Cambridge's Professor of Mineralogy, in the fist decade of the nineteenth century. See S. M. Walters and E. A. Stow, *Darwin's Mentor: John Stevens Henslow, 1796-1861* (Cambridge: 2001), 15.

[61] The pedagogical practices of Edinburgh's Medical School are treated in: Lisa Rosner, *Medical education in the age of improvement: Edinburgh students and apprentices 1760-1826* (Edinbugh: 1991); A. Doig, J. P. S. Ferguson, I. A. Milne and R. Passmore (eds), *William Cullen and the eighteenth century medical world* (Edinburgh: 1993).

[62] Charles Alston, *Tirocinium botanicum Edinburgense* (Edinburgi: 1753) EC 57;. Walker's library also contained Alston's *Lectures on the materia medica...*, John Hope (ed.), (Edinburgh: 1770) EC 64 and EC 220 (the latter had 'MS additions, apparently by the author'). Walker's library also contained 'Original Letters from Boerhaave, Dr. Fothergill and other eminent men of that time, to the late Dr. Alston, handsomly bound' EC 562.

and Lord Bute[64] (to name a few). This situation, in addition to basic philosophical disputes over vocabulary and mineralogy's close interaction with pharmacology and chemistry, insured that it was not completely dominated by Linnæus.

Disagreements over vocabulary created a context where the very words used to identify taxonomical categories could not be agreed upon. As will be shown in the next chapter, Walker's syllabi and his mineralogical system are arranged based upon the Linnaean concept of class, order, genus and species. However, when trying to compare the organisation of his syllabus to other contemporary systems, it becomes clear that the application of taxonomical vocabulary was inconsistent throughout Europe. The best examples of this situation are the taxonomies of Da Costa, Cronstedt and Bergman. Although Da Costa shared Linnæus' preference for natural characters, the two major divisions in his system were 'earths' and 'stones' (as opposed to Linnæus' 'stones', 'minerals' and 'fossils'). He called both of these a 'Section'. The major distinction for each Section was a 'Chapter'. In contrast, both Cronstedt and Bergman used Linnaean nomenclature to divide their system into classes. Cronstedt divided his earths into 'orders', while Bergman's used 'species', 'genus', and 'class', but not orders.[65] This difference in the definitions of nomenclatural vocabulary makes it rather tricky to compare Walker's system to those of the various authors that he references in his lectures. This is not only symptomatic of Walker's syllabi, but for most mineralogies of the time.[66]

III. Mineralogical Vocabulary

Definitions and Characters

For a field that was so interested in naming and ordering, it is quite surprising to find that little work has been done in recent years on the actual vocabulary that was being used by seventeenth and eighteenth century mineralogists. It is therefore the primary goal of this section to address where Walker obtained his mineralogical vocabulary. Before he could create a mineralogical system, he had to select the descriptive adjectives and taxonomical terms that he was going to use. Like

[63] J. Hill, *The vegetable system. Or, the internal structure and the life of plants*... (London: 1775-1786) EC 84.
[64], John Stuart, Earl of Bute, *Botanical tables, containing the different families of British plants*... (London: 1784). It also should be noted that Walker was privy to Bute's opinions and natural history collection.
[65] Bergman's impact on chemistry and mineralogy in Britain has yet to be assessed. In addition to the Latin books held in Walker's library, he also had written a plethora of individual dissertations and treatises (many of which were printed in London and Edinburgh) on individual Earths and Salts. Bergmans' affinity tables also were included in chemistry books written in English. See J. Elliot, *Elements of the branches of natural philosophy connected with medicine*... (London: 1782) and J. Parkinson, *The chemical pocket-book, or memoranda chemical*..., (London: 1807). Bergman also popularised chemistry via his *An essay on the usefulness of chemistry*..., (London: 1784).
[66] For a comparison of the early systems used by Walker Appendix III.

Cullen's medical taxonomies and Linnæus' arrangement of the three kingdoms of nature, Walker's choice of vocabulary was closely linked to a definition and division methodology. As with most systems of natural history in Walker's time, much of the arrangement came down to how the naturalist defined the categories. Linnæus set the example for this approach by giving a long list of terms and definitions at the beginning of his *Systema Naturœ*. Similarly, the lecture outlines and class notes of Cullen and Black demonstrate that they too were keen on defining key terms that were relevant to the topic under discussion.

By the late eighteenth century, mineralogical vocabulary in Edinburgh was closely tied to the conception of *characters*, that is, the empirical data generated by a natural object. Walker's conception of a character was most significantly influenced by Cullen and Linnæus. In his lectures given during the 1750s, Cullen was fond of using the word 'fact' to denote the raw empirical properties that could be gathered together to form the basis of a 'principle'. But by the 1760s, he seems to have replaced this general conception of a 'fact' with the Linnaean 'character'. By the late 1760s both Cullen and Walker were applying this term and their version of the Linnæan system to medicine and natural history.[67] The continued influence of this Scottish-Linnæanism upon Walker can be seen throughout his lectures, but it is most clearly stated in his lecture entitled 'Imperium Naturæ or The Empire of Nature'.[68] Here, Walker clearly states that using the definition and division model to classify the natural world is based on characters. He held that the epistemological certitude of a character was dependent upon it being obtained through personal observation or from oral or printed accounts that demonstrate fidelity to accurate description and observation.[69]

Walker included an 'Imperium Naturæ' lecture every year. Those given during most of his tenure state that there were three basic types of characters that could be used to arrange animals, plants and minerals. An *Essential character* consisted 'only of one individual character, by which a particular body is clearly

[67] Cullen organised his lectures by arranging medical 'characters' so that they formed classification categories. He then printed these categories, or 'heads', and distributed them to his students. From these, his students compiled their notes and the first *Institutions of medicine* (Edinburgh, 1772). For Cullen's direct application of Linnaeus, see *Nosology, or, A systematic arrangement of diseases: by classes, orders, genera, and species... and outlines of the systems of Sauvages, Linnaeus, Vogel, Sagar, and Macbride...* (Edinburgh: 1800).

[68] *Natural History Lectures Vol. I* (1789) EUL Gen 50, ff. 113-124); *Natural History Lectures Vol. II* (1790) EUL DC.2.24, ff. 236-254 and continued in EUL DC.2.25, ff. 1); *An epitome of natural history Vol. III* (1797), EUL Gen 705.D, ff. 130-162). Scott includes a copy of it taken from DC.2.18, which is undated. Based on several internal references, it was probably written in the mid to latter 1790s.

[69] Epistemic questions of believability and the value of a gentleman's word within scientific discourse are raised in S. Shapin's *A social history of truth* (Chicago: 1995). Walker accepts natural history testimony if it conforms with what he or his colleagues have personally observed or if it agrees with other authors whose observations have been reliable in the past. For more on this context, see S. Shapin, 'The Audience for Science in Eighteenth Century Edinburgh', *HS*, **22** (1974), 95-121 and J. Golinski *Science as Public Culture* (Cambridge: 1992).

distinguished by all others.'[70] Echoing Aristotle, essential characters described the individual 'parts' of a natural object.[71] A *Natural character* was 'the delineation and description of the whole parts of the body' as it existed 'naturally' in nature. It looked at essential characters in regard to how they were related to the whole natural object under consideration. In plants, for example, it was the essential characters associated with reproduction that proved to be the most important natural character for Linnæus. A *Factitious character* was a unique property that did not usually occur in natural objects that shared similar essential and natural characters. It was used to classify a natural object when one or several of these essential or natural characters were found wanting. Once essential, natural and factitious characters were determined, division and arrangement could take place.

One problem with the characters named above is that they were originally developed for the classification of plants. Throughout the eighteenth century it was quite common for naturalists to 'transplant' these characters into zoological and mineralogical classification systems. In his mineralogy lectures, Walker listed characters at the beginning of each mineral class and order. In contrast to the three different types of characters used for botany, he generally used two types for mineralogical classification: *character naturalis* and *character chemicus*. The former, like the one defined in the above paragraph, was taken directly from Linnæus' mineralogy. Walker's natural characters were delineated by the use of *Situm*, *Consistentiam*, *Partes*, *Substantiam*, *Figuram*, *Qualitates* and *Structuram* (Situation, Consistence, Parts, Substance, Figure, Qualities and Structure).[72] Walker's chemical characters, however, seem to be a combination of his conception of an essential and a factitious character. They were obtained via chemical tests involving the use of *menstrua*, *solutio*, *crystallisatio*, *igne votutantio*, *calcinatio*, *fusio*, and *vitrificatio* (Menstrua, Solution, Crystallisation, Fire, Calcination, Fusion and Vitrification). These forms of analyses were standard in late eighteenth century Edinburgh. It seems that Walker, like Bergman, did not attempt to establish a connection between chemical composition and the expression of natural (external) characters.[73] In addition to the chemical characters obtained by the seven tests named above, Walker would sometimes insert additional ones to further explain

[70] 'IMPERIUM NATURÆ or EMPIRE OF NATURE, vizt. The Fossil, Vegetable and Animal Kingdoms'. This lecture is housed in EUL DC. 2-18 and is printed in Walker (1966), 214-222. All quotations in the paragraph are taken from the former source.
[71] Linnæus' Aristotelian foundations are discussed in detail in Stafleu, especially in Chapters 2 through 4.
[72] Pollock's translation of the characters: (1797), *An epitome of natural history Vol. IV*, EUL Gen. 706D, f. 7.
[73] W. R. Albury and D. R. Oldroyd discuss this point in relation to Bergman in 'From Renaissance Mineral Studies to Historical Geology, in the Light of Michel Foucault's *The Order of Things*', *BJHS*, 10 (1977), 187-215, see especially page 197.

composition or structure. These were mostly taken from chemical and mineralogical textbooks and from Walker's involvement with Edinburgh's chemistry community.

Classical Vocabulary

The terminological influence of classical writers upon early modern mineralogy has yet to be studied in detail. Even though Walker mentioned Theophrastus' *De lapidibus*,[74] he was fonder of citing Pliny's *Historia naturalis*, both in his early notebooks and in his lectures.[75] Pliny discusses minerals in books XXXIII (Metals), XXXIV (Ores), XXXVI (Stones), XXXVII (Precious Stones). The immense influence of the mineralogical vocabulary in this text on Walker and his contemporaries should not be underestimated. Indeed, Walker used Plinian names for many of his genera: 'The number of Genera is exceedingly extensive and it is proper that each should have a name, for this purpose many of the Classical names of Pliny are adopted.'[76] Based on this position, it should not be surprising that even several of his class names were based on terms taken directly from Pliny's *Historia naturalis*: calcareous, gypseous, siliceous and steatitical.[77] He also used the term 'apyrite' and this obtained by adding the Greek negation prefix, 'a', to pyrites.[78] Like Linnæus' nomenclature, the mineralogical vocabulary used by Theophrastus and Pliny provided a common reference point for an international community of natural philosophers who could read and write Latin.[79] However, since early modern mineralogists had difficulty in identifying the actual composition of Pliny's minerals (as is the case even today), the same Latin names were often applied to completely different stones.[80] A good example of this is Agricola's use of *stannum* in *De Re Metallica* (1556). In this work, he interpreted Pliny's *stannum* to be the correct term for lead-silver alloys. This definitional difference caused problems for the next two

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[74] Some work has been done in this area by Annibale Mottana, 'Il libro Sulle pietre di Teofrasto : prima traduzione italiana con un vocabolario di termini mineralogici ; memoria di Annibale Mottana e Michele Napolitano', *Atti della Accademia nazionale dei Lincei* (1997), 8, 151-234.

[75] Walker cites Pliny's comments on porphyry in the report (*Kings* MS) that he wrote on the Hebrides for George III. See John Walker, *The Rev. Dr. John Walker's report on the Hebrides of 1764 and 1771*, Margaret M. McKay (ed), (Edinburgh: 1980), 190. For the importance of Pliny's *Historia naturalis* in history, see E. W. Gudger, 'Pliny's Historia naturalis. The most popular natural history ever published', *Isis*, 6 (1924.), 269-281.

[76] Walker (1966), 'Mineralogy Lecture', 229.

[77] Pliny the Elder, *Pliny. Natural history*, H. Rackham (trans), (London: 1912). For these names, see the following sections: calcareous (36.174-176); gypseous (36.182); siliceous (36.168); steatitical (37.186).

[78] Pliny (1912), (36.137). For more on Pliny's mineralogical names, see J. F. Healy, *Pliny the Elder on science and technology* (Oxford: OUP, 1999), 115-141; 173-346. See also the 'Index of Minerals' in H. Rackham's introduction to *Pliny* (1912), 419-421.

[79] Indeed, at the University of Edinburgh, students were required to write their medical dissertations in Latin all the way to the end of the eighteenth century. For the influence of medical Latin in England and in continental Europe, see W. Bracke and H. Deumen (eds), *Medical Latin from the Late Middle Ages to the Eighteenth Century* (Brussels: 2000).

[80] D. E. Eichholz briefly treats this problem in the introduction to Loeb edition of Pliny's *Naturalis historia*: *Pliny natural history with an English translation in ten volumes, volume X, libri XXXVI-XXXVII* (Cambridge, Mass.: 1962), ix-xv.

centuries because *stannum* was generally associated with tin, not lead.[81] In addition to interpretational differences on what terms actually meant in their Latin context, there was also a great deal of disagreement over how Pliny's terms should be translated into the vernacular.

Despite these hermeneutic problems, the actual terms that Pliny used to describe both the natural and the artificial (chemical) characters of minerals were recycled over and over again in early modern mineralogical works. Pliny's natural characters most often utilized colour, texture and shape. Walker even cites a few of these terms. For instance, he uses the adjective '*cæcum*' because it was 'a Term used by Pliny, and which, indeed, is very useful in Mineralogy, to denote the lowest degree of transparency.'[82] No only did Pliny's vocabulary serve as a guide for descriptive adjectives, it also standardised the names given to fossils that were anthropomorphic, zoomorphic or astralmorphic. For instance, Walker uses the Plinian words glossopetra and asteria to name stones that resemble tongues and stars.[83] Pliny also addressed what Walker would have seen as chemical characters. The Roman use of heat in metallurgy and 'saline' mixtures in the cleaning and assaying of gems was quite a complex business and would have resonated with Walker's interest in five-principle chemistry.[84] Additionally, the plethora of Pliny's mineralogically based pharmaceutical formulas would have interested Walker's colleagues in the Medical School.[85] In general, Pliny's wide variety of physical and chemical vocabulary gave Walker and many other mineralogists words that could not only be used for individual minerals, but in the wider sense of taxonomical vocabulary. It is for this reason that many of the names that his contemporaries gave to species, genera, orders and classes in his system had corollaries in Pliny's work.[86]

Botanical & Chemical Vocabulary

During the mid eighteenth century, the seeming simplicity of Linnæus' binomial nomenclature and his definition and division methodology tempted many naturalists into applying his system to mineralogy. A leader in this movement was

[81] See G. Agricola, *De Re Metallica: Translated from the first Latin edition of 1556*, H. C. Hoover and L H. Hoover (trans), (New York: 1950), 473 and ff. 33.
[82] Pollock (1797), *An epitome of natural history Vol. IV*, Gen. 706D, f. 26.
[83] Chapter III discussed these terms because they were included in the mineral list of Walker's *Adversaria*. For glossopetra (tonguestone), see *Naturalis historia* (37.164). For asteria (star stone), see (37.131). These names also had been quite common since the middle-ages.
[84] For more on the interaction of mineralogy and chemistry in classical times, see K. C. Bailey (trans.), *The Elder Pliny's chapters on chemical subjects* (London: 1932); F. Greenaway, 'Chemical Tests in Pliny', in R. French and F. Greenaway (eds), *Science in the early Roman empire: Pliny the Elder, his sources and influence* (London: 1986), 147-161.
[85] Even though Pliny gives numerous pharmacological recipes, he is critical about the state of pharmacology in Rome. See § 34.108.
[86] Pliny's mineralogy is also briefly discussed in R. French, *Ancient natural history* (London: 1994), 233-240.

Linnæus himself. For terminological simplicity, he turned to the botanical Latin that he had already developed for his own system.[87] Many of these words were descriptive adjectives that addressed a plant's morphology and/or colour. The original purpose of these words was to describe the essential characters of the plant, which, for Linnæus, were the parts associated with the plant's reproduction. These characters were externally observable and were divorced from any Platonic conception of an existent, but unobservable, form. When Linnæus began to classify minerals, he decided that the characters by which stones should be classified were, once again, externally observable morphological parts. Thus, the term *rhombus* could not only be applied to the shape of a leaf, but also to the crystalline appearance of a mineral. Likewise, the term *albus* (white) could be used to describe a flower or a type of marble.[88] The dual use of such words was not unique to Linnæus. By the late eighteenth century his system had become a common comparison point for mineralogical and botanical vocabulary in Britain. Likewise, most naturalists of the time saw no problem with 'transplanting' botanical terms into mineralogy. Numerous examples of this dual terminological usage could be cited from Walker and his contemporaries alone. For example, in his early lectures on mineralogical topics, William Cullen used botanical words like foliaceous and fibrous to describe a species of gypsum.[89] Indeed, Walker's personal notes and his lectures are filled with similar instances.[90]

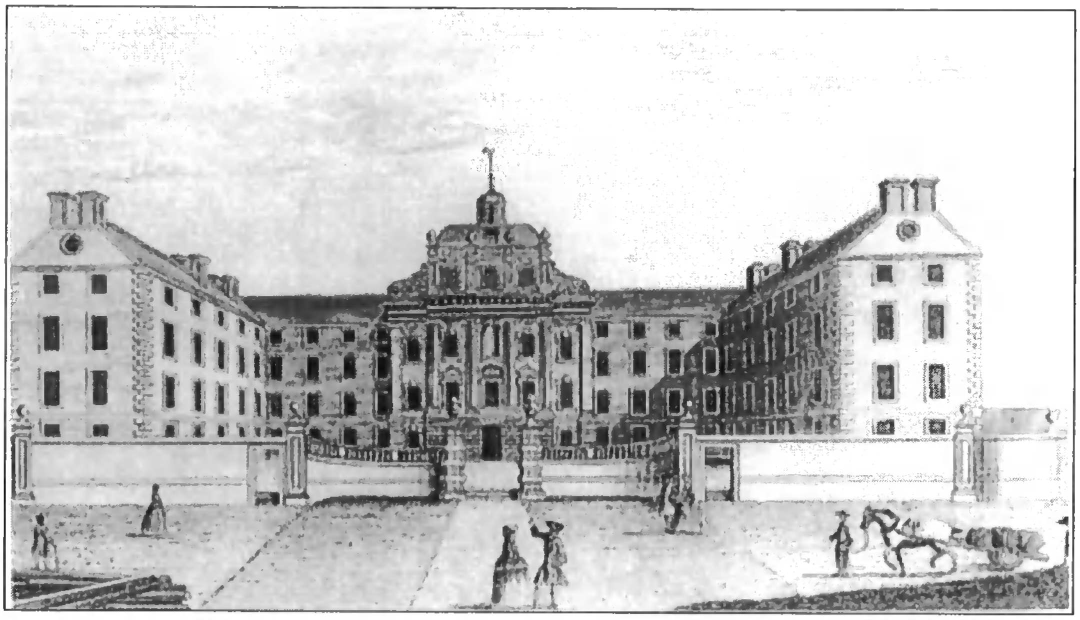
Botanical vocabulary was convenient for those who thought that minerals should be arranged by their externally observable characters. The wide circulation of Linnæus' works later in the century ensured that these mineralogists were at least using the same words to describe similar stones. However, Linnaeus' naturally based, but externally focused, vocabulary presented a few problems for mineralogists like Walker, Cullen and others who came from traditions influenced by the Becher-Stahl School of chemistry. Even though they accepted Linnaeus' definition and division methodology, they based their systems on internal chemical characters. Furthermore, although Linnæus' basic chemical vocabulary was firmly grounded in the five-principle chemistry that was used in Edinburgh's Medical School (especially

[87] The classic source for Linnæus' botanical Latin is W. T. Stearn's *Botanical Latin: History, grammar, syntax, terminology and vocabulary* (Newton Abbot: 1973).
[88] *Ibid.*, 311-357.
[89] Cullen used the words foliaceous and fibrous to describe different types of Gypseous Earth. GUL Cullen MS 264. See *OED* for further eighteenth century mineralogical uses.
[90] While travelling in the Hebrides during 1764, Walker noted the similarity between amiantus and petrified wood fibres. Walker (1980), 219. Also see the vocabulary terms in Pollock EUL 706D, ff. 6-32; 36-40.

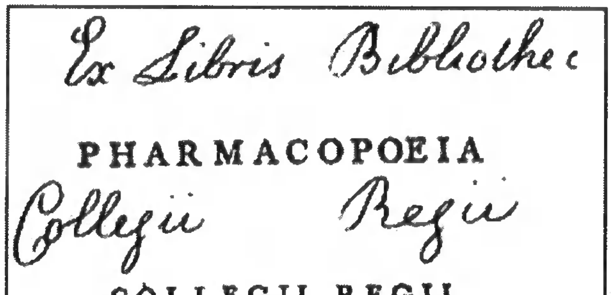
in pharmacology),[91] he only used chemical characters as a last resort.[92] This meant that his system did not provide a vocabulary robust enough to create names for a mineralogical system based primarily on chemical characters. Another standard Latin source, therefore, was needed to provide names for the chemical characters which could be used to classify minerals. For the Scots trained in Edinburgh's Medical School, this source was five-principle chemistry.

From the 1750s to the 1790s, the different definitions associated with the key terms of the five-principle system further complicated the vocabulary available to Walker and his contemporaries (Plate 4.IV). For instance, Walker's teacher Charles Alston offered several alternate classifications for minerals in his *materia medica* lectures.[93] Cullen's interest in systematizing chemistry led him to draw his vocabulary from works that fell firmly within the Becher-Stahl School tradition. However, he was not completely happy with the mineralogical applications of Stahl's chemistry and this is why he was so excited when he was given a copy of Cronstedt's *Versuch einer neuen Mineralogie* in 1764.[94] Walker's career as mineralogist during the 1760s and 1770s demonstrates that Cronstedt's work in combination with Wallerius' *Minéralogie*[95] probably laid the foundation for a common chemically based vocabulary in Scotland. These works suggested that a chemical mineralogical system that was just as effective as Linnæus' botanical arrangement was possible. Ironically, some of their descriptive adjectives were the same as Linnæus, (who was their contemporary in Uppsala)—the key difference being that the terms were reinterpreted in light of chemical composition. The mineralogical terms promoted by Cronstedt and Wallerius were further canonised in Edinburgh's Medical School after the English translation of Bergman's *Outlines of Mineralogy* was published in 1783.[96] Although all three of these Swedes disagreed on several points, the vocabulary and the system of arrangement they used were similar and their works became a standard source for the chemical mineralogy as practiced by Cullen, Walker and Black.

[91] Stearn addresses these chemical terms on pages 358-363. For the meaning and historical background of pharmaceutical terms, see W. E. Flood, *The origins of chemical names* (London: 1963); J. W. Cooper and A. C. McLaren, *Latin for pharmaceutical students* (London: 1950).
[92] He believed this because he believed that chemical analysis destroyed a mineral's essential. See C. Linne, *A general system of nature, through the three grand kingdoms of animals, vegetables, and minerals…*, William Turton (trans.) (London: 1804), 9.
[93] This was often influenced by how the mineralogical simple was being use in a compound. For more on Alston's views on mineralogical simples, see his *Index medicamentorum simplicium triplex* (Edinburgi: 1752), 69-70.
[94] See A. F. Cronstedt, *Versuch einer neuen mineralogie aus dem Schwedischen übersetzt*, G. Wiedeman (trans) (Kopenhagen, 1760). Whether or not this is the copy used by Cullen is unknown.
[95] Wallerius (1753).
[96] Tobern Bergman, *Outlines of mineralogy*, W. Withering (Trans), (Birmingham: 1783).



The Edinburgh Infirmary, (c. 1750)
A. Doig, *et al.*, *William Cullen and the eighteenth century medical world* (Edinburgh: 1993).



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PHARMACOPOEIA

Collegii Regii

COLLEGII REGII

Medicor Edinburg.

MEDICORUM

EDINBURGENSIS.

EDINBURGI:

Apud G. DRUMMOND et J. BELL.

MDCCLXXIV.

The Edinburgh Pharmacopoeia (1774)

Experimental pharmacology played a strong role in the development of drugs in Edinburgh's Medical School. Because it employed principle-based chemistry, its mineralogical systems used chemical characters and vocabulary. Pictured on top is the Edinburgh Infirmary—the place where drugs were tested. On the bottom is the edition of the Edinburgh pharmacopoeia that was edited by William Cullen in 1774. Many of the simples in its pages use Metals and Earths as their main active ingredient.

Local Vocabularies

In addition to consulting printed sources, Walker also took his mineralogical vocabulary from his local environment. One source for these words and terms was quite removed from the academic environment of Edinburgh. As Scott pointed out so many years ago, Walker incorporated several mining words like 'streik' and 'dip' into his lectures.[97] Another source was the anglicised vocabulary associated with local pharmacological cures and folklore. Throughout his lectures, Walker not only stated the Latin name of a mineral, he also gave its local name so that his students would know to which stones he was referring. Hence, words like 'Toad Stone', 'Whin Rock', 'Serpent Stone' and 'Plum Pudding Stone', all are included for their local significance. Other vernacular terms came from anthropologically inspired words like 'rib', 'bowels' and 'vein'.[98] Although a twenty-first century historian might be tempted to see the origins of words as metaphorical, Walker's lectures make it clear that many of these names were inspired by what the local people had thought the stones were actually made of.

Another source of local mineralogical vocabulary was the academic environment of Edinburgh. Included in such a 'local reality' were the lectures that Walker attended while he was a student and the societies he joined as an adult. In this context medicine and natural history were seen as complementary subjects. As Cullen stated in his chemistry lectures: 'That physic leads to the study of all nature, a few obvious considerations will immediately discover to you.'[99] After this statement, he then went on to tease out the medical relevance of the history of animals, vegetables and minerals. Based on this outlook, it should come as no surprise to see that Walker was taking most of his mineralogical terms from botany and chemistry, topics which were part of the medical curriculum As such, they existed within spaces that were keenly interested in describing, studying and curing the human body. Within this environment, scientific Latin was the main language of description and this allowed many words to be used analogically in different fields. (Indeed, many have suggested that Hutton's conception of the earth was based upon biological metaphors and analogies.[100] An excellent example of this overlap in

[97] Walker (1966), 181.
[98] The potential problem of vernacular terms is addressed P. N. W. Jackson (1999) throughout his article. See also W. J. Arkell and S. I. Tomkeiff, *English rock terms: chiefly as used by miners and quarrymen* (London: 1953)
[99] J. Thomson, *Account of the life, lectures, and writings of William Cullen, M.D. vol II* (Edinburgh: 1832), 664-665.
[100] This was voiced as for back as the 1960s by R. Hookyaas in 'A new illustration of the Huttonian theory', *Atlas*, **3** (1967), 177-179. It received later attention by R. Grant's 'Hutton's theory of the earth' and L. J. Jordanova's 'Earth Science and environmental medicine: the synthesis of the late Enlightenment', both in L. J. Jordanova, R. S. Porter (eds), in *Images of the earth* (Chalfont St. Gilles: 1979), 23-38; 119-146.

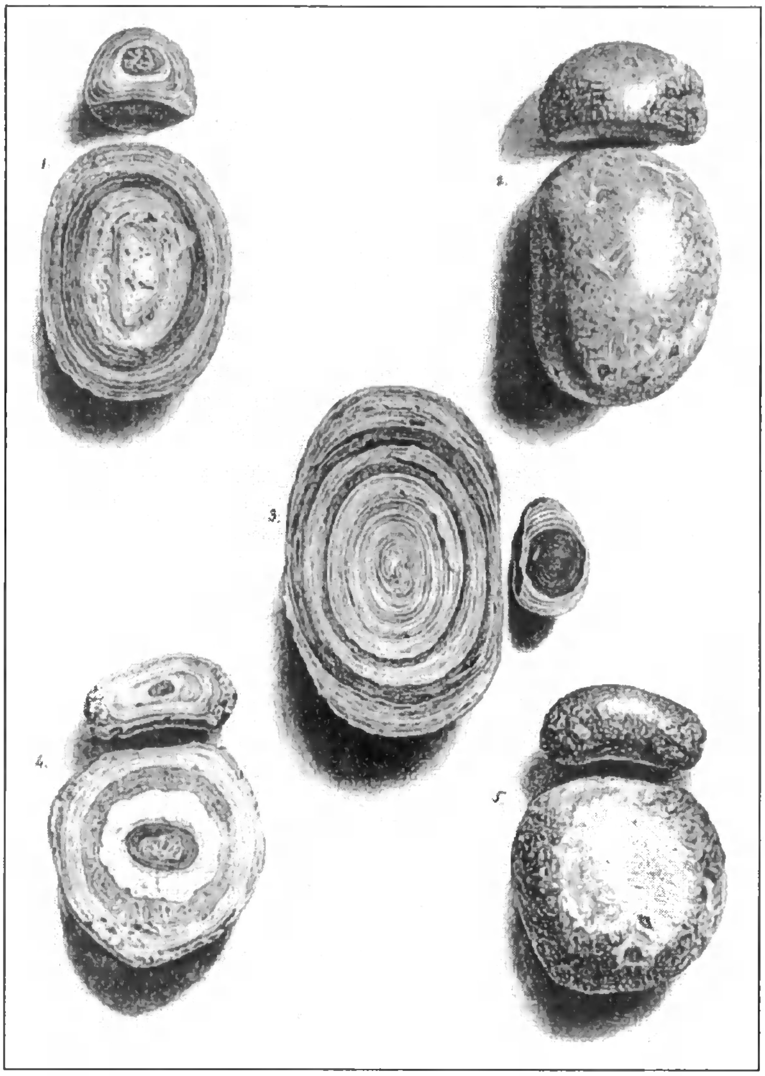
scientific language was the transfer of chemical terms from experiments on bladder 'stones' to those on 'stones' taken our of the earth. See Plate 4.V).[101]

Based on Walker's lectures notes, it seems that the medical connotations of his vocabulary implicitly allowed him to look at the earth as a physician would look at the human body. For instance, for natural characters, he used words like 'vagum', 'sterile', 'stratum', 'tegmen', 'nodus', 'venigenum', 'cortex', 'nucleus' and 'septa' in ways that mirrored their anatomical and botanical usage.[102] For chemical characters, he used the same terms as the physicians who were doing experiments on stomach acids and various pharmaceuticals. Such an anthropocentric mindset and vocabulary would have implicitly affected Walker's view of the earth. This is supported by the fact that his lectures on both mineralogy and geology often treat the earth as if it were a body. Likewise, his commitment to a rigid empirical epistemology also allowed him to hold himself to be an impartial observer, just as the physicians were taught to do with their patients. It was like this for many of the mineralogists whom he read and with whom he corresponded. As such, much of the mineralogical vocabulary that has been construed as metaphorical might have been used in a more literal sense, thereby making local vocabularies much more important than many historians have realised.[103]

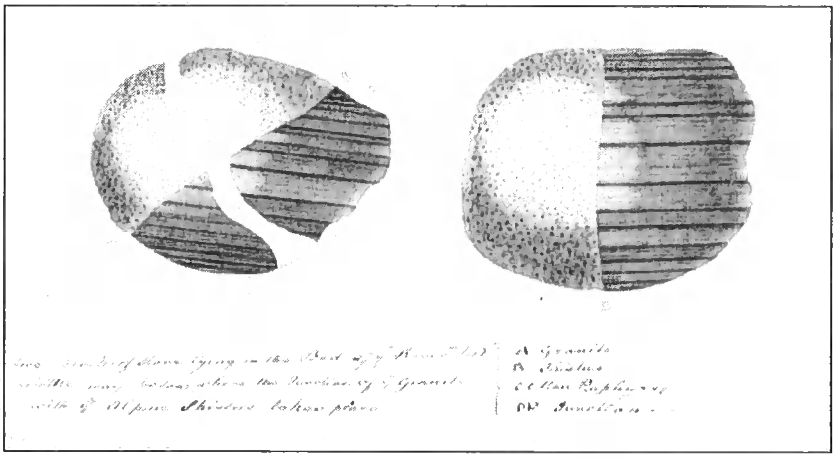
Conclusion

This chapter has addressed the sources and vocabulary which played a foundational role in the mineralogical system that Walker taught his students during his tenure as the University of Edinburgh's Professor of Natural History. Section I used Walker as an example to demonstrate the general neglect that has been paid to eighteenth-century mineralogical sources. Using student notes and a posthumous catalogue of Walker's library, Section II went on to identify the canon of mineralogical works that informed his system. A large percentage of these sources were from the continent and demonstrate he was particularly interested in Swedish mineralogists and French principle-based chemistry. Section III showed that, to 'define' minerals, Walker took the bulk of his mineralogical vocabulary from classical, chemical, botanical and local sources. Based on the medical context that

[101] This transfer of vocabulary is detailed in Eddy (2004).
[102] These all can be found in his initial section on definitions: Pollock (1797), *An epitome of natural history Vol. IV*, Gen. 706D, ff. 7-27.
[103] B. Duden addresses the limits and relevance of metaphorical and literal language in relation to medical case studies and diagnosis during the eighteenth century in 'Medicine and the history of the body: the lady of the court', in J. Lachmund and G. Stollberg (eds), *The social construction of illness* (Stuttgart: 1992), 39-51



Urinary Calculi
Printers proof of plate 12 on William Hunter's unpublished work on calculi
Huntarian Library T.3.9; also in Bynum and Porter, *William Hunter...* (Cambridge: 1985), 306.



Boulders from the River Tilt, Tayside (c. 1785)
Annotated engraving based on a drawing done by John Clerk of Eldin (1728-1812)
G. Y. Craig (ed), *James Hutton's theory of the earth. Reproductions of drawings...* (Edinburgh: 1978), 30.

In Edinburgh, the chemical language used to describe bodily and earthly 'stones' was the same. This allowed the chemical composition and the stratified nature of organically created objects like bladder stones (above) to serve as a conceptual foundation for understanding the composition of much larger mineralogical formations (like the boulder stones pictured below).

influenced Walker's methodology and vocabulary, I concluded that section by suggesting that Walker and his contemporaries could have possibly viewed the earth as a physician would have viewed the human body. Naturally this needs further investigation, but the medical foundations of mineralogy during the early modern period are an important facet of the nascent earth sciences that has been curiously ignored.

One significant point that emerged in this chapter was that Walker's library had a surprisingly low number of printed Scottish sources—including chorographies (or even books that treat the travelling history of Scotland in general).[104] The lack of such sources, especially in chemistry, demonstrates that Walker was most probably informed on Scottish scientific endeavours via word of mouth and correspondence. Mineralogically speaking, the absence of books written about Scottish geography might be attributed to the fact that many of these works tended to highlight sensational aspects about the Scottish landscape, history and people—especially if they were being pitched to readers in England. Walker probably felt that these works were not worthy of consultation since they tended to rehash the same information over and over again and because they were often written by those who had done whistle stop tours of their own shires and counties. Perhaps Walker also shied away from chorographies because he wanted to observe an area's natural history personally.

More importantly, this chapter reinforces the emphasis that the past two chapters placed upon chemistry. Walker's preference for sources and vocabularies that address chemical mineralogy demonstrate that he felt that artificial (chemical) characters were more expedient than natural ones. Based on Walker's situation, it seems quite possible that Edinburgh had its own canon for these areas and it would be interesting to see how it compares to the medical communities in London, Paris, Stockholm and Leyden. No doubt these individual canons would overlap at some points, but where they differ just might help clarify the different receptions received by the new nomenclature at the end of the century. In order to understand the full impact that chemistry had upon Walker's mineralogy, a detailed study of his system is necessary. This is therefore the goal of Chapter 5. Once this is accomplished, further studies will be able to compare Walker's system to those who practiced

[104] The strong presence of Scottish chorographies during the Enlightenment has been detailed by Withers in *Geography, science and national identity: Scotland since 1520* (Cambridge: 2001).

chemical mineralogy (and other closely related topics like 'geology') both in Edinburgh and abroad.

Chapter 5

Systematising Minerals

Introduction

Having explained Walker's mineralogical sources and vocabulary in the previous chapter, the primary goal of the present chapter is to examine the context and content of the mineralogical systems that he taught his students during his tenure as the Professor of Natural History in the University of Edinburgh's Medical School (1779-1803). In what follows, the word 'system' is employed as Walker himself used the term in his lectures, that is, a methodological arrangement of data. Section I looks at the nomenclature that he used to arrange minerals. It begins by outlining the general problems encountered by historians when they attempt to investigate this topic and then moves on explain the nomenclature that Walker used in his system. It ends by showing that, like his earlier attempts at mineralogical classification, his later systems were based predominantly upon chemical characters. This sets the stage for Section II which details how he used chemistry to create classes, orders, genera and species. For reasons that will be explained, particular attention is given to the arrangement of his 1797 system. This discussion will be based mostly on manuscript sources, especially student class notes and the personal notes and correspondence of Walker himself. This section, which I have named 'Walker's System', shows that he divided his final classification scheme into nineteen classes that were grouped into two major categories: Stones and Minerals. The classes of these two categories will be identified in conversation with the characters that he used to make each class. One of the main points that I will make is that Walker used an artificial (chemical) methodology to create all but four of his nineteen classes. I will then conclude with a summary and by making a few interesting points about the relevance of his approach to mineralogical systematics.

I. Classifying Minerals

The Problem of Nomenclature

As I demonstrated in the last chapter, mineralogical nomenclature and vocabulary were closely related in Walker's time. This being the case, the multifaceted world of eighteenth-century nomenclature, as understood by its practitioners, is often drastically simplified or glossed over by Enlightenment historians. From a philosophical standpoint, the epistemological underpinning of nomenclature and systematic classification in Enlightenment Britain is usually reduced to the issue of 'natural kinds'. After preliminary remarks on the cultural import of Baconian empiricism and Newton's *hypotheses non fingo*, the traditional starting point for investigating natural kinds is usually John Locke's *Essay Concerning Human Understanding*. We are told that three things from this work are important in relation to the development of eighteenth-century classification systems: 1) the use and definition of the 'kind', 'sort' and 'quality',[1] 2) primary and secondary qualities, 3) primary and secondary ideas.[2] Even though Locke's own vocabulary is sometimes ill-defined on several of these points and despite the fact that the term 'natural kind' is not even listed in the appendix of the seventeenth-century versions of the *Essay*, the next step is to use Locke's epistemology to frame the classification system outlined by Linnaeus in his *Systema Naturæ*. This is often done in a general way by stating that Linnaeus was influenced by Locke's *Essay*, or in a more specific fashion by equating Locke's 'sort' and 'kind' with Linnaeus' 'species' and 'genera'.[3]

This narrative is helpful for historians and philosophers interested in setting out the basic terms used to build eighteenth-century classification systems. Indeed, I will build on several of the above premises in the next chapter on Walker's geology. However, the apparent simplicity often assigned to Enlightenment nomenclature by intellectual historians has been the subject of much criticism in recent years—both from historians and philosophers.[4] As I will show there and below, the above account should be seen only as a starting point for two significant reasons. First, it

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* Sections of this paper were presented on the 28th of November 2002 at the 'Problems in the History of Science and Technology' Michaelmas 2002 seminar series held by the University of Oxford's Modern History Faculty and at the 'Spaces of Classification' workshop hosted by the Max Planck Institute for the History of Science held in Berlin from December 12th to the 14th 2002. It has since been published in the workshop's preprint. A special thanks to D. M. Knight, D. R. Oldroyd, Ursula Klein, Susan McMahon, Gordan McOuat, Staffan Müller-Wille, Michael Barfoot, Robert Fox, Hjalmar Fors, William A. Kelly and the NAHSTE project and the University libraries of Durham, Newcastle and Edinburgh for advice given on this chapter.

[1] Attention is often drawn to Locke's comments in Book III, Chapters I – VII. Locke (Oxford: 1988), 402-473.

[2] An excellent book that gives a clear explication of Locke's conception of 'substance' and 'idea' is E. J. Lowe's *Locke on human understanding* (London: 2000).

[3] As Cain states it: 'He [Locke] prefers the English 'sort' and 'kind' to the Latin 'species' and 'genus' (iii.i.6). A. J. Cain, 'John Locke on Species', *ANH*, **24** (1997), 337-360. Quotation from page 341.

[4] See the first three chapters of John Dupré's *The disorder of things: metaphysical foundations of the disunity of science* (Cambridge, Mass: 1995).

privileges Locke and Linnaeus (or other canonical natural philosophers like Robert Boyle)[5] over other systems that had enjoyed considerable circulation—especially those of a chemical or of a local origin. For instance, John Thomson (Cullen's biographer) had kind words for 'Mr. Locke's excellent account of our complex ideas of substances, or the use of general terms, and of the names of substances.' However, he qualifies this assessment by stating that 'no other author' had since been able to interpret Locke more clearly than Scotland's own Dugald Stewart.[6] Second, different cultural and linguistic contexts often affected the vocabulary of taxonomical nomenclature—a point previously mentioned in this thesis.[7] On the most obvious level, this meant that the words and terms of a given nomenclature took on different definitions in separate countries and in specific local realities. The lack of standardised dictionaries also meant that there were definitional differences within the same language, or that definitions were so vague that ambiguities were inevitable.

Such a point can be easily demonstrated by looking up 'species' in the *Oxford English Dictionary.* There are at least twelve relevant definitions (each with several sub-definitions that include historical examples) that can be applied to the seventeenth and eighteenth centuries. Additionally, these definitions are samples taken from sources that were written and published in England, Ireland, Wales and Scotland. This means that differences between different intellectual contexts are not accounted for. Naturally, to include local varieties of every word is clearly out of the *OED's* scope, but this does not eliminate the fact that there often were inconsistent definitions given to 'species' by different local realities.[8] This is especially the case for mineralogies based on chemistry because the definitions were not standardised.[9] Furthermore, even Locke and Linnaeus gave rather broad definitions for 'species'. Locke's following definition is a case in point: 'The individuals that are ranked into

[5] Even though Walker references some of Boyle's works, it is unclear how much respect he held for Boyle's natural philosophy. Boyle was also a proponent of corpuscular chemistry, something which Cullen felt was of no help to analyzing the composition of matter. John Thomson would eventually look back and chastise Boyle for being too credulous over the 'efficacy of periapts and amulets'. J. Thomson, *Account of the life, lectures, and writings of William Cullen, M.D, vol II* (Edinburgh: 1832), 558-559.

[6] J. Thomson, (Edinburgh: 1832), vol. II, 191. Thomson was specifically referring to Stewart's *Elements of the philosophy of the human mind* (London: T. Cadell, 1792)—a book which Walker had in his library.

[7] Porter, Teich, Bensuade-Vincent and Abbri have pointed out how national contexts influenced the reception of and development of scientific ideas during the Enlightenment. See R. Porter and M. Teich (eds), *The enlightenment in national context* (CUP, 1981); B. Bensaude-Vincent and F Abbri (eds), *Lavoisier in European context: Negotiating a new language for chemistry* (Canton, Mass.: 1995).

[8] For a helpful discussion of 'species' during this time period see the following two articles by A. J Cain: 'Thomas Sydenham, John Ray, and Some Contemporaries Species', *ANH*, **26** (1999), 85-100; 'John Ray on "Accidents"', *ANH*, **23** (1996), 343-368.

[9] Indeed, even though the *OED* refers to Robert Boyle's *A continuation of new experiments physico-mechanical touching the spring and weight of the air* (London: 1682), page 108, its earliest entry for the chemical usage of 'species' is the 1857 edition of W. A. Miller's *Elements of chemistry: theoretical and practical, vol. III* (London: 1857-60), page 45. For a recent discussion of chemical 'languages' during the eighteenth-century, see Chapter 5 in M. Beretta's, *The enlightenment of matter* (Canton: 1993), 245-322.

one sort, called by one common name, and so received as being of one *species*.'[10] Translations of the term taken from Linnaeus' *Systema Naturæ* were also quite broad. For instance, an 1804 edition states: 'SPECIES, the division of family or genus, containing such as agreed with its generic factor.'[11]

If trans-national differences were not enough, there were also disputes within localised contexts. The University of Edinburgh's Medical School was not immune to this problem. Its professors used the concept of mineral 'species' as a taxonomical distinction when classifying all three kingdoms of nature: animal, mineral and vegetable. It was also used in chemistry and the related fields of *materia medica* and medical theory.[12] Within this context, disputes arose over what constituted a 'species' and whether or not empirical 'characters' could be considered as essential representations of a natural object.[13] It was for this reason that Linnaeus' system was opposed by several professors (Charles Alston for example).[14] Such differing positions also explain why Walker had so much trouble getting 'the Great Swede' elected to the Philosophical Society of Edinburgh in 1762. These taxonomical disagreements irritated William Cullen so much that he attempted to standardise classification by authoring several works on medical systematics. As was mentioned in Chapter 2, his first attempts at systemisation occurred in the field of chemistry, but he would go on to address medical practice,[15] nosology[16] and *materia medica*.[17]

Taking these contextual factors into consideration, I return to Locke and Linnaeus. Even though it is true that Locke called for more linguistic clarity and that Linnaeus' works help standardise eighteenth-century taxonomical vocabulary, this does not mean that their thoughts can automatically be considered to be normative, especially in a context like Enlightenment Edinburgh. There is no doubt that Lockean empiricism ran rampant, but in the end, even he had argued that the 'idea' of a species was merely linguistic and could never represent a natural object's essence: 'But I think it is nevertheless true, that *the boundaries of the Species,*

[10] Emphasis added. Locke (Oxford: 1988), iii. vi. §8.
[11] C. Linne, *A general system of nature, through the three grand kingdoms of animals, vegetables, and minerals... Vol. VII*, W. Turton (trans.), (Swansea: 1804), 'Explanation of Terms Used in the Departments of Natural History' (no page numbers). Knight and Crombie treat the context of eighteenth-century nomenclature in more detail. See Chapter 16, 'Search for a Natural System' in A. C. Crombie, *Styles of scientific thinking in the European tradition: the history of argument and explanation especially in the mathematical and biomedical sciences and arts, Vol. 2* (London: 1994), 1262-1292'; Chapter 3, 'The Artificial System', in D. M. Knight, *Ordering the world* (London: 1981), 58-81.
[12] It should be remembered that several of the authors cited in conjunction with medicinal wells in Walker's 1761 *Index Librorum* used the word 'species' as a taxonomical division for Salts. For instance, see Frederick Slare, 'An Examen of *Chalybeat*, or *Spa-Waters*', *PT*, **28** (1713), 247-251, esp. p. 250.
[13] On of the most notable of these debates occurred as a reaction to the fact that Linnaeus had chosen to classify the human 'species' within the same genus as certain primates. For more on these debates, see Peter Jones (ed), *The 'Science of man' in the Scottish enlightenment: Hume, Reid and their contemporaries* (EUL: 1989).
[14] Alston presented his own botanical classification in *Tirocinium botanicum Edinburgense* (Edinburgi: 1753).
[15] William Cullen, *Institutions of medicine: Part I. Physiology* (Edinburgh: 1785).
[16] William Cullen, *Synopsis nosologiae methodicae: in usum studiosorum* (Edinburgi: 1772).
[17] William Cullen, *Lectures on the materia medica* (London: 1773).

whereby Men sort them, are made by Men.'[18] Such a notion was firmly believed within the Medical School and they had no problem recalibrating words and terms to fit the data generated by the experimental culture of their intellectual community. Because there were so many differing conceptions of nomenclatural terms, this chapter will address Walker's later mineralogical systems in relation to (1) the books contained in his library (2) the manuscripts that he wrote and (3) other mineralogical ideas that circulated amongst those who either studied or taught in the University of Edinburgh's Medical School.

Nomenclature and 'Methodising'

All of the mineralogy systems that Walker taught during his tenure at the University of Edinburgh were based on five chemical principles: Salt, Earth, Inflammable, Metal and Water. Previous chapters have shown that he had learned this form of chemistry in the Medical School under the instruction of William Cullen during the 1750s and had used it to create a rudimentary mineralogical schema during the 1760s. By the 1780s he had developed this arrangement into a full fledged mineralogical system that consisted of two major categories. First, there were the Stones (or Lapides). These were fossils in which the largest chemical component was a Primary Earth. Since the early part of the century, there had been many debates as to the exact number and composition of Primary Earths. Although Johan Gottschalk Wallerius and Axel Frederick Cronstedt had influenced Walker's early mineralogical education on this topic (Plate 5.I), by the 1780s, Walker had come to accept the five Primary Earths of Swedish chemist Torbern Bergman: calcareous, argillaceous, magnesia, terra ponderosa and siliceous.[19] The second overarching category was 'Minerals' and this included Salts, Metals and Inflammables.

Walker used two types of characters in all of his mineralogical systems: natural and artificial.[20] His 'artificial' character was approximately the same as the 'factious' character that he mentions in his 'Imperium Naturæ' lectures (as detailed in Chapter 4). Unlike his botanical arrangement, he does not use essential characters

[18] Locke's italics, *Essay* iii.vi.37, Locke (Oxford: 1988), 462.
[19] Tobern Bergman *Outlines of Mineralogy* (Birmingham: 1783), § 85.
[20] In using 'natural' and 'artificial', Walker was building on a tradition most often associated with Linnaeus. However these distinctions had been around for quit a while—especially in mineralogy and early attempts at chemical analysis. See R. Hookyaas, 'The discrimination between "natural" and "artificial" substances and the development of corpuscular theory', *AIHS*, 4 (1948), 640-651.

comme ils font ordinairement mêlés avec de la Terre, ou de la Pierre (mêlange que les Mineurs appellent *Minéraux*); & comme lorsqu'on les trouve purs & vierges, ils ne laissent pas d'être fortement attachés à la Pierre ou à la Terre; on a préféré à la division précédente, celle qui est en usage parmi ceux qui travaillent les Mines; on la trouvera dans le paragraphe suivant.

§. 4.

Les Minéraux ou Fossiles se divisent en quatre Classes principales.

1°. En Terres, (*Terræ.*) ce font des substances minérales composées de particules non compactes & non liées les unes aux autres, qui ne se dissolvent ni dans l'huile ni dans l'eau, quoiqu'elles puissent y être délayées ou divisées; on peut les regarder comme la matiere primitive des pierres.

2°. En Pierres, (*Lapides.*) ce font des corps solides & compactes, dont les parties font étroitement liées les unes aux autres, qui ne contiennent rien qui puisse se dissoudre dans l'eau ou dans l'huile, qui par conséquent ne peuvent point s'y amol-

A ij

lir, qui en se réfroidissant après la fusion deviennent concaves à la surface, & dont la masse fondue est plus légére que n'étoit la Pierre avant que d'entrer en fusion.

3°. Les Minéraux (*Mineræ.*) ce font des corps composés de Terre & de Pierre, qui contiennent ou du Sel ou du Soufre, ou du Métal parfait, ou du Métal imparfait, c'est-à-dire une substance qui n'est soluble ni dans l'eau ni dans l'huile; (*Voyez les* § 3 *&* 4) ou qui prend après la fusion une forme convexe à sa surface, & qui est plus pesante que la Pierre.

4°. Les Concretions (*Concreta.*) L'on nomme ainsi les Fossiles, ou les Minéraux, qui après avoir été détruits, altérés ou décomposés ont été reproduits de nouveau; ou qu'on trouve formés accidentellement dans des endroits où l'on n'est pas en droit de s'y attendre.

Wallerius' Four Stone Divisions
Minéralogie (Paris: 1753)

Wallerius divided his fossils into four categories: *Terres*, *Pierres*, *Minéraux* and *Les Concretions*. Walker followed this practice by using the first three (Soils, Stones and Minerals) and subsuming the fourth under the Stones category. He used Wallerius' conception of a *concretion* to form the only three classes of the Stones that were classified via a natural methodology.

for his mineralogical classification.[21] A natural character was a 'part' of a mineral that could be plainly observed on its external surface or by breaking it open. Characters of this type would include colour, texture, fracture and shape. The way in which a mineralogist obtained these characters was called a *natural method.* It was so called because it sought to approach the mineral exactly as it existed in its natural state. An artificial character, for Walker, was one generated by chemistry. It was 'artificial' because it reduced a mineral to a state in which it did not occur naturally.[22] The process by which a mineralogist obtained these chemical characters was called an *artificial method.* In general, employing solely a natural or artificial methodology inevitably encountered problems. Natural characters had the potential of presenting an unmanageable amount of information and artificial characters became quite hard to determine in stones that contained a wide variety of chemical principles. It was for this reason that most mineralogists during Walkers' time ended up using both kinds of characters. This approach was called the *mixed method.* In Walker's words, it was a method that utilised both 'the natural and the artificial parts, making the one give way to the other occasionally.'[23] Even though Walker clearly states that he used a mixed method, it must be pointed out that about ninety percent of the classes, orders, genera and species of his system are based on chemical, that is, artificial, characters. In fact, many of his divisions are based explicitly upon chemistry and, truth be told, he only used natural characters as a last resort.

Throughout his two decades of lecturing, Walker continually asserted that he did not create new classes, orders or genera *per se*: 'As to the names of the Classes, Orders, and especially those of the Genera, there are none of them new and none of them mine.'[24] However, the apparent simplicity of this position is deceptive because he does not give the specific criteria that he used to select which classes, orders and genera should be included in his system. In all the different versions of his system, Walker remained faithful to the binary classificatory nomenclature used by Linnaeus in *Systema Naturæ*. Even though Walker disagreed with Linnaeus' concentration on

[21] The absence of essential mineralogical characters is probably linked to Walker's views of principle-based chemistry. It seems that he considered the 'pure' form of each principle to be an 'essential character'. In such a line of reasoning, the artificial characters would only be representations of essential characters because of the problems associated with obtaining accurate and/or precise measurement of chemical substances in the laboratory. Such a belief would have been conceptually similar to mineralogists who looked at natural characters (exterior observable colour and composition for example) as 'the epistemological path to the material constituents'. For this latter point, see E. M. Melhado, 'Mineralogy and the autonomy of chemistry around 1800', *Lychnos*, (1990), 229-262; quotation taken from page 233.
[22] Walker defined an artificial method to be: 'When there is one fix'd character established, and all the bodies that posses this character are reduced under that division.' Walker (1966), 'Imperium Naturæ Lecture', 222.
[23] Walker (1966), 'Imperium Naturæ Lecuture', 222.
[24] 'Mineralogy', Scott (1966), 229. [Anon.] *Notes of Walker's lectures on natural history* (c.1790), EUL DC.10.33, f. 332.

natural characters (which were generally externally visible to the naked eye), he felt that 'the Quintuple Division',[25] that is, *classes*, *orders*, *genera*, *species* and *varieties*, laid the foundation for the most logical form of arrangement. Even though he sometimes did use natural characters, the bulk of the characters for his system were provided by chemistry. Although he believed that the chemical approach might one day give way to another more finely tuned classification system, on the whole:

> *This arrangement, the experiments on which it is founded and the Characters of these classes are to be considered as the first and Greatest Achievements in Mineralogy and I conclude with observing that what ever System of Fossils may be established for Naturalists or Chemists, those original Earths are to be considered as the basis of the Classes in Mineralogy.*[26]

In this approach to arrangement he followed Bergman's dictum that, 'In methodizing fossils, *compounds should rank under the most abundant ingredient*.'[27] In this context, 'abundance' was determined by weight. As Albury and Oldroyd explain it: 'If, for example, substance 'xy' contained more 'x' than 'y', then it should belong to the genus 'x'.'[28] The unit of measurement was the 'grain' and composition was listed in parts per one hundred. This was commonly practiced in both chemistry and mineralogy and can be clearly seen in Nicholson's popular *First Principles of Chemistry* (1802) (Plate 5.II). Like most chemists, Walker formed classes and orders based on the chemical characters associated with Primary Earths. He also used these for determining genera and species, but occasionally had to revert to natural characters. This did not change throughout his teaching career and he summed it up about five years before he died. He stated that chemical properties, 'form, generally, the leading Character of the Classes and Orders. And the natural Properties the subordinate & distinctive Character of Genera and Species. A Method, & properly executed, equally useful to the Naturalist and Chemist.'[29]

Although the general structure of Walker's system remained relatively unchanged, he was continually making minor readjustments to it. On the whole,

[25] David Pollock (transcriber), *An epitome of natural history* (1797), hereafter EUL Gen. 706D, f. 6.
[26] *Lectures on natural history* (1790), EUL DC.2.25, f. 23.
[27] Bergman (1783), §14.
[28] Albury, W. R. and D. R. Oldroyd. 'From Renaissance Mineral Studies to Historical Geology, in the Light of Michel Foucault's *The Order of Things*', *BJHS*, **10** (1977)187-215, quotation from page 197. The debates concerning Bergman's use of 'equivalent' weights during the 1970s illustrates the linguistic and conceptual difficulties presented to modern scholars when trying to understand eighteenth-century scientific measurement. For comparative weights and measures from this time, see T. Thomson (ed), *Annals of philosophy*, **1** (1813), 452-457. For more on the debate, see the following articles: J. A. Schufle and G. Thomas, 'Equivalent weights from Bergman's data on phlogiston content of metals', *Isis*, **62** (1971), 499-506; W. A. Smeaton, 'Bergman's "Equivalents": a correction', *Isis*, **64** (1973), 231; J. A. Schufle, 'Reply by J. A. Schufle', *Isis*, **64** (1973), 231; C. S. Smith, 'Bergman's "Equivalents": a further comment', *Isis*, **65** (1974), 393-394; J. A. Schufle, 'Further reply on Bergman's "Equivalents"', *Isis*, **66** (1975), 404.
[29] *Systema Fossilium*, f. 22-24. He made similar statements throughout his lecturing career. For instance, compare the above statement to the following: '[T]he characters of the Classes & Orders must be formed on Chemical principles. While those of the Genera, Species and Varieties seem to depend chiefly upon their natural marks.' [Anon.], (transcriber), *Notes of Dr. Walker's lectures of natural history*, DC.10.33, f. 330. See also Pollock (transcriber), *An Epitome of natural history* (1797), EUL 706D, f. 35.

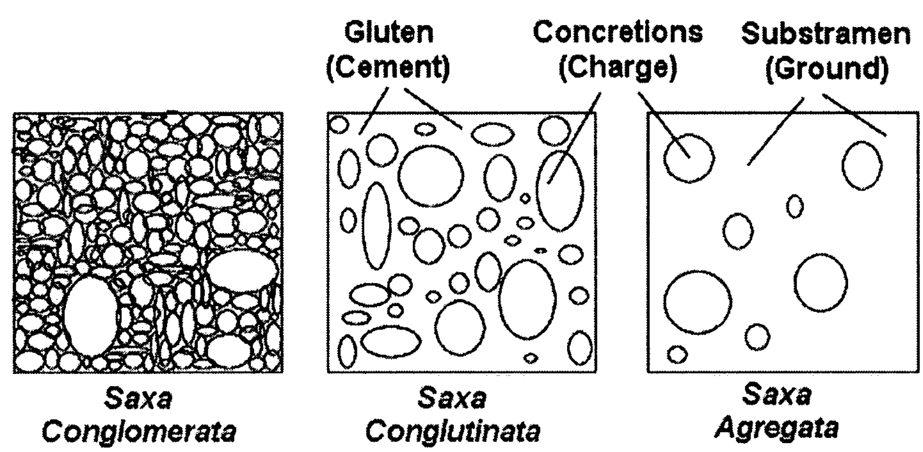
TABLE XIII. Of the Proportion of Ingredients in Earths and Stones.

Calcareous Genus.

100 Parts.	Calcar.	Argill.	Silex.	Mag.	Wat.	Iron.
Calcareous ſpar	55	- -	- -	—	11	—a
Gypſum	32	- -	- -	—	38	—b
Fluor	57	- -	- -	—	—	—c
Tungſten	50	- -	- -	—	—	—d
Compound ſpar	60	- -	- -	35	—	5e
Cruetzenwald ſtone	75	- -	- -	12	—	3f
Calcareous marle	50to75	20to30	20to30	—	—	—g
Margodes	50	32	15	—	—	2
Stellated ſpar	66	- -	30	—	—	3
Calcareous grit or ſand ſtone	50	- -	- -	—	—	—h
Swine ſtone	95	- -	- -	—	—	—i
Pyritaceous limeſtone	75	14	- -	—	—	4k
Martial tungſten	- -	- -	- -	—	—	0 l

a And 34 fixed air.——b And 30 vitriolic acid.——c 43 acid and water.——d 50 acid and iron.——e Both earths mild.——f Ditto.——g And water.——h Or more; remainder, ſilex, argill. and iron.——i And petrol. j remainder, argill. and iron.——k And 7 quartz and ſulphur, that is, 25 pyritæ.——l By the dry way only 30, and 50 tungſten.

Nicholson's the Composition Chart for Calcareous Stones.
William Nicholson, *The first principles of chemistry* (London: 1796), 561



Walker's Saxa Stones

these changes mainly concerned genera and species, and not classes and orders. The first class was always 'Terræ' and his last five classes were always 'Minerals' (salia, inflammabilia, pyritae, semimetalla and metalla).[30] Likewise, even though he might sometimes change their sequential number, he kept the same name for most of the stone classes.[31] A comparison of all his personal notes, the fifteen or so student notebooks housed in Edinburgh libraries and the catalogue that he made for the Edinburgh Natural History museum around 1795 indicates that his system went through at least three stages. The first was when it was created in 1781. This was called *Schediasma fossilium* and it consisted of 18 classes.[32] The second occurred around 1790 and the number of the classes went up to 19. This change is most clearly represented in manuscript copies of student notebooks.[33] Although he began to lose his eyesight in the mid 1790s, the final stage occurred around 1795 when he decided to create a catalogue for the mineralogy collection that was under his supervision in the University of Edinburgh's Natural History Museum. This was named *Systema Fossilium* and it consisted of 19 classes.[34]

Chemical Characters

Even though chemistry formed the methodological base of his system, it is extremely difficult to ascertain Walker's position on the ontological status of the chemical principles that he employed. How Salts and Earths actually came into existence and whether or not some of them resulted from one or two primordial substances is not clearly addressed in Walker's lectures. One of his students recorded one of the few treatments of the subject in his 1797 notes. Walker is noted as saying: 'It has been a long controverted Question: whether or not, the Earths in the Fossil Kingdome are capable of a Chymical Union without a Saline Principle?'

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[30] See Appendix III.

[31] But, there were some changes. He had originally included Fusoria (Class 5) in his 1781 system. But by 1790 he had replaced it with Ponderosa and Amandina.

[32] John Walker, *Schediasma fossilium* (Edinburgh: 1781) EUL DC.2.19 and *Schediasma fossilium* [with notations], EUL DC.8.20. In 1786, he began to amend *Schediasma* by moving around its orders and by listing more characters—artificial (chemical) and natural—for each fossil. These corrections were not that substantial, and in 1787 he published these augmentations of *Schediasma* and as *Classes Fossilium*. Part of this was reprinted in the third edition of Robert Jameson's *A system of mineralogy* (Edinburgh: 1820), xxxiii-xxiv. Its full title was: John Walker, *Classes Fossilium: sive, characteres naturales et chymici classium et ordinum in systemate minerali : cum nominibus genericis adscriptis* (Edinburgi: 1787) and it is No. 427 in Elliot's *Catalogue*. That it was known in British mineralogical circles is evinced in fact that it is listed in Joseph Banks' library: Jona Dryander, *Catalogus bibliothecæ... Tome iv. Mineralogi* (London: 1799), 13. It is one of the few Scottish books in his collection. The only copy that I have been able to find of it is the one housed in the University of Oxford: OUM Mineral 549/14. This could possibly be the copy used by Walker's student Thomas Beddoes when he was lecturing there in early 1790s. During this time Beddoes would collect minerals with Davies Gilbert and then use them as illustrations in his lectures. See the 'Introduction' in R. Siegfried and R. H. Dott (eds), *Humphry Davy on Geology: The 1805 Lectures for the General Audience* (Madison: 1980), xix; Roy Porter, *Doctor of society: Thomas Beddoes and the sick trade in Late-Enlightenment England* (London: 1992), 13.

[33] As demonstrated in [Anon.] (transcriber), *Lectures on natural history* (1790), EUL DC.2.25, f. 62 and [Anon.] (transcriber), *Lecture on natural history vol. III* (1790s), EUL DC.2.19, f. 3.

[34] John Walker, *Systema fossilium* (c. 1797), GUL, Bound MS Murray Gen. 1061.

His answer to this is about the clearest explication of this matter found in any of his lectures: 'Bergman was of the Opinion that they could, but there are many Presumptions to make us suppose the Contrary.'[35] After this brief statement, Walker closes the discussion. Keeping Walker's above statement in mind, it is interesting to note that earlier in his career (1773), when he was not such a public figure, he admitted to Lord Kames that:

> *Organisation is not so well understood formerly as at present. I was taught from the Professor's Chair when I was fourteen, that there was an organisation in the fossil kingdom; but I have long learned that there is not. It is now universally admitted, that there is no seminal principle in fossils, no containing vessels nor contained fluids, no organization, no species, but possible combinations, innumerable as the sands of the sea.*[36]

What remained behind these possible combinations was not a subject that he wished to address. In this sense, throughout his career he falls more in line with chemists like Bergman, and even Lavoisier, who did not want to discuss the possibility of 'primordial elements' until there was more information available.[37] In practice, his Earths, Salts and Metals functioned both as a metaphysical 'principles' *and* as empirical 'characters'. Like Cullen, Wallerius and Bergman,[38] Walker called these principles/characters 'Primary', or 'Primitive', and he grouped them in the following manner:

Primary Earths	**Primary Salts**	**Primary Metals**
Calcareous	Acids	Iron
Argillaceous	Alkalis	Copper
Magnesia		Lead
Terra Ponderosa		Tin
Siliceous		Silver
		Gold

It is also unclear how much Walker's acceptance of chemical principles was dependent upon his own chemical prowess and how much of it depended upon the advice of his Edinburgh colleagues like Cullen, Black and Thomas Charles Hope. Additionally, I have not been able to ascertain if he personally tested the chemical composition of all the minerals in his systems or if he at times relied on the writings

[35] Pollock (transcriber), *An epitome of natural history* (1797), EUL Gen 706D D, f. 42. Walker also briefly mentions 'Whether these earths are capable of uniting' in [Anon.] (transcriber), *Notes of Walker's lectures on natural history* (c.1790), EUL DC.10.33, f. 332. Even though this is a 'curious question', he does not give it any further treatment.

[36] A. F. Tytler of Woodhouselee, *Memoirs of the life and writings of the Honourable Henry Home of Kames...., Vol. II* (Edinburgh: 1807-1809), Appendix II, 33.

[37] This would change after the work of John Dalton. See H. Cassebaum and G. B. Kauffman, 'The Analytical Concept of a Chemical Element in the Work of Bergman and Scheele', *AS*, **33** (1976), 447-456, esp. 452-454.

[38] Bergman argued that these principles were not 'metaphysical' because they demonstrated observable empirical properties. Beretta touches upon this point when discussing Bergman's *chemia sublimior*. See Beretta (Canton: 1995), 134-149. These 'properties' were closely linked to Bergman's conception of chemical affinity. See Duncan (Oxford: 1996), 136-145; 148-153.

of Wallerius, Bergman, William Watson, Wilhelm Scheele, Richard Kirwan and Joseph Priestley. What is clear is that the chemical training that Walker received from Cullen and the Medical School during the 1750s influenced him for his entire career. This training in combination with the experimental chemistry being conducted in the Medical School during the 1780s and 1790s determined many of the writings he was willing to accept as valid. For instance, his affinity for Bergman was no doubt linked to the fact that Bergman's system was similar to mineralogical classification employed by Cullen and Black.[39]

No matter what Walker thought about the philosophical strengths or weaknesses of principle based chemistry, using the characters generated by these chemical distinctions to arrange minerals was not without its difficulties; and Walker clearly states this in his lectures.[40] One of the biggest problems was that many stones could not be easily reduced to one or more of the Primary Earths. There were also problems with isolating Salts. These problems were not unique to Walker. In fact, this was a difficulty for five-principle chemistry in general. For stones, Bergman had tried to sidestep this issue by creating 'derivative' earths, that is, 'those which consist of two more of these [Primary Earths] intimately united.'[41] The 'force' that held them together was a highly localised conception of 'affinity'. Even though Walker does not explicitly state it in his methodology sections, he accepted this approach. As we will see in the following sections, he considered several chemical substances to be Derivative, or, as he sometimes states, Secondary:

Secondary Earths	**Secondary Salts**	**Secondary Metals**
Steatite	Neutral	Pyrites
Amiantina	Acid-Earth	Semimetals
Schista	Alkali-Earth	
	Vitriol	

Walker followed Bergman's belief that these Secondary compounds could be bound together quite tightly, or as Bergman states, they had 'a mutual attraction to each other, and form combinations more intimate than mechanical ones.'[42] By logical extension, Walker used these Secondary compounds as characters when he could not find characters that represented Earth, Salt or Metal principles. His classes were therefore based on the Primary and Secondary characters that comprised the largest percentage of the 'fossil' under consideration. It was only after he could not classify

[39] Duncan has argued that there was a 'strong probability' that Bergman was influenced by Cullen and Black. See A. M. Duncan, *Laws and order in eighteenth-century chemistry* (Oxford: 1996), 127-129; 146-147.
[40] Walker (1966), 'Mineralogy Lecture' 226-227.
[41] Bergman (1783), § 83.
[42] Bergman (1783), § 103.

an object based on these artificial (chemical) characters that Walker would turn to natural (externally observable) characters – and he even held these to have been formed by a chemical process.

The foundational taxonomical role played by chemistry in Walker's thought presents a few key methodological considerations. First, he does not clearly address *why* he equates chemical principles with Linnaeus' definition of a character. Based on the highly empirical nature of his lectures, it was unlike him not to at least mention such an issue. It would seem that he accepted the metaphysical role of these chemical principles because those whose chemical abilities he held in high esteem, namely Cullen, Wallerius and Bergman, implicitly promoted them. For instance, in his *Outlines*, Bergman lists the five 'Primitive Earths' and then avers: 'And we must believe these to be primitive, until it shall appear by proper experiments that they may be separated into others, still more simple, or changed into one another by art.'[43] If pressed on the issue, Walker would have no doubt admitted that such chemical principles were classification categories that ordered a wide variety of data in a helpful way. A second methodological consideration on this matter is that Walker's Primary and Secondary (derivative) Earths bear a striking resemblance to Locke's Primary and Secondary ideas.[44] Interestingly, as will be shown shortly, Walker also named his Salts 'Primary' and 'Secondary'. Even though his library did not contain a copy of Locke's works, it seems that the cultural import of Lockean epistemology was so strong that he picked up such distinctions from his Edinburgh context and from the books that he was reading.[45]

The difficulties that Walker had with five-principle chemistry's application to mineralogical nomenclature were not unique. As he notes in his mineralogy lectures, chemistry was undergoing a conceptual shift during the last two decades of the eighteenth century. The ontological base of saline, inflammable, aqueous, terrene, and metallic 'principles' had proven to be illusive. The five-principle system came under even more pressure after the 1787 publication of *Méthode de Nomenclature Chimique*[46] and it might not be coincidental that it was in this year that Walker began to re-evaluate his 1781 system (*Schediasma Fossilium*). However, even had the new method caused Walker to rethink his classification, it did not change his fundamental

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[43] Bergman (1783), § 86.
[44] Walker fluctuates between the term 'secondary' and 'derivative' Earths.
[45] Although it could be argued that these distinctions were gleaned independently via ancient and early modern taxonomical arguments that were often read in the form of Aristotle's *Categories*, John Wilkins' *An essay towards a real character, and a philosophical language* (London: 1668) or even Robert Boyle's numerous comments on classification matters in Peter Shaw's collected edition of his works, *The Philosophical works of the Honourable Robert Boyle Esq.* (London: 1738).
[46] Morveau, Lavoisier, Berthollet, and Foucroy, *Methode de nomenclature chimique* (Paris: 1787)

approach. Indeed, it took at least twenty years for Lavoisier's system to be fully assimilated into British chemical and medical communities[47] (and it was challenged by Bergman in Sweden as well).[48] Additionally the disagreements in Scotland over the primacy of Black's ideas and the conservative reaction to the French Revolution seriously impaired Lavoisier's reception.[49]

Since Walker was a personal friend of Black, it should come as no surprise that he was suspicious of the new chemistry (as was James Hutton and Black himself). Generally, it was the younger scholars such as James Hall and Thomas Charles Hope, two of Walker's students, who promoted the new nomenclature of the French. In fact, it was two more of Walker's students, Robert Kerr and William Creech, who were responsible for translating and then publishing the English edition of Lavoisier's *Elements of Chemistry*.[50] As one of the older members of the Medical School, Walker used phlogiston in his mineralogy lectures all the way up to his death and this shows that he based his system on what Oldroyd has called 'Phlogistic Mineral Schemes.'[51] A good example of Walker's sentiments towards the new nomenclature can be seen in a 1798 letter that he wrote to Joseph Black. There he specifically addresses Lavoisier's saline analysis of plants. Although he had 'Reverence for the Genius of Lavoisier', he tells Black that 'Neither he nor his four colleagues, amidst all their high merits, can I view as great Adepts in the Art of Nomenclature.'[52] This suspicion was also shared by several authors of his mineralogical canon—a good example being Richard Kirwan, who published his *Essay on Phlogiston* in 1789 (however, he began to use oxygen in the second, 1794-96, edition of his *Mineralogy*).[53]

[47] R. Siegfried and B. J. Dobbs, 'Composition, A Neglected Aspect of the Chemical Revolution', *AS*, **24** (1968), 275-293 – see esp. page 293. On the medical doctors, see A. Lundgren & B. Bensaude-Vincent, eds, *Communicating chemistry* (Canton: 2000).
[48] M. Beretta, 'T. O. Bergman and the definition of chemistry', *Lychnos*, (1988), 37-67.
[49] For the Scottish community, see A. Donovan's two articles on this context: 'Scottish responses to the new chemistry of Lavoisier', *SECC*, 9 (1979), 237-249; 'Chemistry and philosophy in the Scottish Enlightenment', *SVEC*, **152** (1976), 587-605. Also relevant to this issues is Bensaude-Vincent and Abbri (Canton: 1995).
[50] Antoine Lavoisier, *Elements of chemistry: in a new systematic order, containing all the modern discoveries: illustrated with thirteen copperplates ... ; translated from the French, by Robert Kerr* (Edinburgh: 1790).
[51] D. R. Oldroyd, 'Some Phlogistic Mineralogical Schemes, Illustrative of the Evolution of the Concept of 'Earth' in the 17th and 18th Centuries', *AS*, **31** (1974), 269-305. For a list of Walker's students, see the appendix.
[52] John Walker to Joseph Black, [no month or day given] 1798, EUL Gen. 847/IV ff. 51-52.
[53] R. Kirwan, *An essay on phlogiston and the constitution of acids* (London: 1789); *Elements of mineralogy, with considerable improvements and additions* (London: 1796). Interestingly, Mme. Marie-Anne-Pierrette Paulze Lavoisier translated Kirwan's *Essay on Phlogiston* as *Essai sur le phlogistique et sur la constitution des acides* (Paris: 1788). However, Kirwan's ideas were then refuted by her husband.

II. Walker's System

Orientations

When I was writing this chapter, I presented the following section as a paper at the Max Planck Institute for the History of Science, Berlin. Many of the participants were amazed that it had taken several years of archival work to determine the overarching structure of Walker's system. Furthermore, others wanted to know why some of the Stones in different classes contained the same chemical components, but were classified differently. These questions touch upon two significant historiographical problems that adversely affect the study of early modern classification. The first assumes that the systems found in archives should be similar to the printed accounts that receive attention by most eighteenth-century scholars, namely, the 'standard' sources that I outlined in the first section of this chapter. In reality, the 'messiness' presented by manuscripts is amazingly inconsistent and reveals that there were numerous botanical, zoological and mineralogical systems competing against each other in most countries.[54] The second historiographical problem stems from the commonly held notion that early modern classification systems contained mutually exclusive categories. In Walker's case, he tried hard to differentiate minerals based on composition. However, his system, and most other mineralogies of the time, contained categories that occasionally vied for the same mineral. In these cases, the criteria that a person or community used to discriminate between categories was often linked to contextual influences, or local realities. When these factors are considered, it becomes quite clear that classification was by no means a consistent process in most localities.

Bearing these issues in mind, the following section explains how Walker actually arranged his mineralogical system. For the most part, I will use the 1797 lecture notes taken by David Pollock.[55] Of the many sets of notes taken by Walker's students, these are by far the most detailed that exist. However, Pollock is silent on a few issues and in these cases I refer to other sets of notes (this does not occur very often and I include an explicatory footnote when it does). In almost every case, Walker usually stated the key empirical characters that he associated with each class, order, genus, species and variety. Even so, the characters he associated with some of these categories are only stated and/or defined in his students' manuscripts. This

[54] My interest in manuscripts was first inspired by Gerry Geison in his Darwin course at Princeton. Also see his *The private science of Louis Pasteur* (Princeton: 1996).

[55] A law student who would later become Sir David Pollack, Judge Advocate. Like most manuscript and stenographed notes taken in Walker's lectures, Pollack's sometimes omit information and are unclear in places. In these few instances I will refer to other sets of notes that were taken in the later years of Walker's tenure.

means that the presentation of his conception of minerals is dependant upon notes that are sometimes confusing, incomplete or illegible. These considerations in combination with the tedious nature of the chemistry behind Walker's mineralogy make reconstructing his system a challenging task. Because several parts of the following discussion become quite complex, I have included a table of Walker's classes in Appendix III.

As mentioned earlier, Walker's 1797 system consisted of 19 classes. This arrangement was an expansion from the 18 classes in the first system that he made in 1781. Class 1 was different types of soils. Since his chemically based arrangement of soils was basically a smaller version of other chemical categories used elsewhere in his system, I will set this class aside and not discuss it.[56] Classes 2 through 14 were 'Stones' (or 'Lapides') and classes 15 to 19 were 'Minerals'; the former consisting of Salts (Class 15), Inflammables (Class 16) and Metals (Classes 17 to 19). Walker held that the primary chemical composition of all 'Stones' was a combination of one or more of Bergman's five Primary Earths. The names for these classes came predominately from five-principle chemistry and Pliny the Elder.[57] Walker's stone classes can be further divided into two overarching categories: small and large. Small Stones included classes 2 to 11 and their arrangement was guided by an artificial methodology. Large Stones consisted of Classes 12 to 14 and these were arranged based on a mixed methodology. In what follows, I will first discuss these two types of Stones and then move on to Minerals.[58]

Stones (Classes 2 – 14)

Small Stones were arranged via an artificial chemical method. Their classes were primarily based on the percentage of the different Primary Earths found in each stone and their names are as follows:

Class 2: Calcareous	Class 7: Siliceous
Class 3: Gypseous	Class 8: Steatitical
Class 4: Ponderous	Class 9: Apyrous

[56] Walker held that 'earths' (Class 1: Terra) that is, soils, could not be satisfactorily classified. This being the case, he does attempt to arrange their orders based on chemical characters. For instance, he propounds that 'This is the Class which can have no Place in a Chymical Method; but it is necessary to retain the Earths in a separate Class for the Purposes of Natural History.' Pollock (transcriber), *An epitome of natural history Vol. IV*, EUL Gen. 706D, f. 41. In this case, the 'Purposes of Natural History' was no doubt georgics (Walker tried to obtain the Chair of Agriculture in the 1790s) and this is probably why there are three different sets of lecture notes (in different handwriting) on Class 1 contained in [Anon.] (transcriber), *Notes of Walker's lectures on natural history* (c.1790), EUL DC.10.33, ff. 332-292.

[57] For specific examples of these names, see Section III of Chapter 4.

[58] In this section and those that follow, attention will be given to the Stone names as Walker understood them to be. Identifying how his Stones names compare to those used in modern mineralogy exceeds the current constraints of this chapter. Two good sources for such a comparison are: M. F. Heddle, *The mineralogy of Scotland vols. I – II* (St. Andrews: 1924) and A. M. Clark, *Hey's mineral index: Mineral species, varieties and synonyms* (London: 1993). Heddle's work will have additional interest to those interested in the Gaelic names and locals associated with several Scottish minerals.

Class 5: Phosphoric	Class 10: Zeolitical
Class 6: Amandina	Class 11: Micaceous

Unfortunately, the exact quantity of each stone's terrene component is not always listed in notes taken during Walker's lectures. Usually, the composition of the stone is listed in order of abundance. The Earth that had the highest weight in the composition was used to determine a stone's class (this is often done without any numbers being given to explain the exact percentage of each Earth). Thus, the main criterion for a Calcareous Stone (Class 2) was a high proportion of Calcareous Earth.[59] Likewise, the most abundant chemical character of classes Gypseous Stone (Class 3)[60] and Phosphoric Stone (Class 5)[61] was, once again, Calcareous Earth. Even though Walker held that the latter's basic component was Calcareous Earth, it appears that he could not determine whether the other component was sulphur (Wallerius) or 'Acidum opatosum' (Scheele).[62] Similarly, although Zeolitical Stone (Class 10) contained Calcareous Earth, Walker seems to have been even more unsure as to which Primary Earth made up the composition. Without naming page numbers (which commonly occurs), Pollock's notes cite the work of three authors on this topic: Torbern Bergman,[63] Johann Anton Scopoli and Jean-Baptiste-Michel Bucquet.[64] Each one of them held a different position on Zeolite's chemical composition:[65] Walker, however, seems to have concluded that the main component was Siliceous Earth.

Class 4 consisted of Ponderous Stones. As the name suggests, their largest chemical component was Ponderous Earth, which was an Earth proposed by

[59] This was qualified by the fact that they could be 'converted into quicklime by Fire'. Pollock (transcriber), *An epitome of natural history Vol. IV* (1797), Gen 706D, f. 160. Earlier in the 1790s, Walker had hinted that presence of Aerial Acid was also a characteristic of these stones, going as far to assert that, 'Of all the Calcareous Earths, chalk contains the largest proportion of Aerial Acid. Mr. Kirwan found no less than 40 per cent in it.' [Anon.] *Notes of Dr. Walker's lectures of natural history*, DC.10.33, f. 343. Because Walker does not give specific composition Just what percentage of Calcareous Earth or Aerial Acid needed to be present in Walker's conception of a Calcareous Stone is unclear. In general, there was no consensus on this point at this time. It is for this reason that Walker cites different Calcareous Stone chemical compositions from various mineralogies for every order.

[60] Gypseous Stone (Class 3) was Calcareous Earth that had been combined with vitriolic acid. Pollock (transcriber), *An epitome of natural history Vol. V* (1797), Gen. 707D, f. 7-8.

[61] Composed of a Calcareous spar and gained its name because of its ability to burn. Pollock (transcriber), *An epitome of natural history Vol. V.* Gen. 707D (1797), f. 29.

[62] Walker cites Wallerius and Cronstedt (but not Scheele) on this point. See parts 172 and 176 of Wallerius', *Systema mineralogicum* Vol. I (Holmiae: 1772) EC 401 and § 23 of Cronstedt's, *An essay towards a system of mineralogy ... Vol. I* (London: 1788) EC 408. For these citations, see Pollock (transcriber), *An Epitome of natural history*, (1797), EUL Gen. 707D f. 85. The same authors are cited in the section on zeolite in [Anon.] (transcriber) *Notes of Dr. Walker's lectures of natural history*, DC.10.33.

[63] Bergman (1783), § 121, thought it was Argillaceous Earth. On this point Bergman cites §§ 108-112 of Cronstedt's *Mineralogy* (no doubt one of the Swedish editions).

[64] G. A. Scopoli, *Principia mineralogiæ systematicæ et practicæ*. (Vetro-Pragæ: 1772) EC 209. For more on Scapoli's approach to clasification see: *Introductio ad historiam naturalem sistens genera lapidum, plantarum et animalium: hactenus detecta, caracteribus essentialibus donata, in tribus divisa, subinde ad leges naturae* (Vienna: 1772). J. B. M. Bucquet, *Introduction à l'étude des corps naturels tirés du règne minéral, par M. Bucquet,...* (Paris: 1771) [not in EC]. Even though Walker mentions Bergman, Scopoli and Bucquet in his main lecture section on zeolitical stones, he does not cite them in the bibliographical (further reading) section listed at the end of Pollock's notes. The main authors cited for Zeolitical Earths are, once again. Wallerius and Cronstedt. See Pollock (transcriber), *An epitome of natural history* vol. VI (1797), EUL Gen. 708D, ff. 201-207.

[65] Pollock (transcriber), *An epitome of natural history* vol. VI (1797), EUL Gen. 708D, f. 9.

Bergman in 1774.[66] Class 6 contained Amandina Stones. It seems that their shared chemical character was iron (garnets are part of this class). However, some of the chemical compositions listed for each Amandina genus demonstrate that the ferrous component was quite low. Walker probably thought that iron produced the reddish colour of the rocks and so he therefore included them in this class. His Siliceous Stones (Class 7) had compositions dominated by Siliceous Earth.[67] Gems and diamonds were included in this class.[68] Apyrous Stones (Class 9) also contained a notable proportion of Siliceous Earth.[69] The composition of Steatitical Stones (Class 8) was Earth of Magnesia and a bit of Siliceous Earth. Micaceous Stones (Class 11) were 'Stones which contain the Earth of Magnesia, combined with that of Alum.'[70]

Walker's conception of classes 12 to 14 was quite important because it set the epistemological foundation for his understanding of geology. The names for these classes were as follows:

Class 12: Petræ

Class 13: Saxa

Class 14: Concreta

In classifying these stones, his methodology took a distinct shift. Instead of an artificial method predominantly based on chemical characters/principles, he changed to a mixed method in which he used both chemical and natural characters to create the class. Using the Primary Earths as characters worked well for the earths and Stones that composed his first 11 classes because their compositions were not very complex. Yet this artificial method presented a problem for stones like the ones in classes 12 to 14 which were larger or more heterogeneous. Thus, the criteria for these classes consisted of natural characters (size and, to a lesser extant shape) *and* a much wider variety of artificial (chemical) characters. For the latter, Walker treats combinations of Primary Earths (Steatite, Amiantina and Schista for example) as characters that can be used to classify several of the orders. In doing so, he followed Bergman's practice of using Derivative (Secondary) Earths to classify minerals.[71] Yet, inherent to the very ontology of natural characters of the Stones in Classes 12 to

[66] Walker States: 'The Fossils of this Class, are chiefly composed of the Terra Ponderosa, or Barytes'. Bergman (1783) addresses Ponderous Earth in §§ 87 – 91.
[67] This is further qualified: 'This class comprehends the Bodies which strike Fire with Steel, and are composed of Siliceous Earth.' Pollock (transcriber), *An epitome of natural history vol. V* (1797), Gen. 707D f. 117.
[68] Pollock (transcriber), *An epitome of natural history vol. V* (1797), Gen. 707D, ff. 161-165. The second author was Franz Carl Achard (1753-1821). Walker is referring to his *Chemische untersuchung verschiedener edelgesteine* [Chemical Analysis of Various Gems] (Berlin: 1778). Which version Walker consulted is not known.
[69] A further quality was that they 'resist the Fire without any visible change.' Pollock's notes in this section contain a table that demonstrates that the main component of Apyrous Stones is Siliceous Earth. Gen. 707D, f. 185.
[70] Pollock (transcriber), *An Epitome of natural history vol. VI* (1797), Gen. 708D, f. 19
[71] Bergman (1783), § 83.

14 (size for instance) is the fact that all of their physical form was implicitly the result of a chemical process that had taken place in the distant past.

Walker defines Petræ Stones (Class 12) as both 'heterogeneous' and 'Simple'. They are 'Rocks... which the naked Eye cannot observe more than one sort of Particles',[72] a description which clearly shows them to be a type of hardened chemical mixture.[73] As the 'Situs' entry in Pollock's notes demonstrates, Petræ stones are very large pieces that have broken off of larger rocks (e.g. primary and secondary strata).[74] Unlike the massive Petræ Stones, Concretion Stones (Class 14), operated on a smaller, more local scale and included concretions formed from Earths, Water, fire and from Metals.[75] Class 13 was comprised of Saxa Stones (Plate 5.III). Walker held that, 'This Class forms the greatest Proportion of the Mass of Matter in this Globe, and though it is a subject of much Importance, it is the least cultivated Part of Mineralogy.'[76] He also pointed out that previous chemical mineralogical systems had reduced these stones to an appendix.[77] Furthermore, he states that there are three distinguishing 'Parts' to any Saxa Stone: *substramen*[78] (or Ground), *gluten*[79] (or Cement) and *concretions*[80] (or Charge):[81] 'The Substramen and the Gluten compose the cementing or uniting Matter, and the Concretions are the Matter cemented or united.' The only difference between substramen and gluten was in

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[72] The description is virtually the same as that given for 'Petra' in the definition section at the beginning of the lecture notes. Pollock (transcriber), *An epitome of natural history vol. VI* (1797), Gen 708D, f. 10. The structure of a Petra Stone is: '*Indeterminata, æqualis, frustulosa, fissilis, porosa, foraminosa. Determinata, lasnellosa, vel angulata. Pectem compactum æquale, obscurum: Concretionibus nudo oculo ibviis, vex ullis.*' Pollock (transcriber), *An epitome of natural history vol. VI* (1797), Gen. 708D, ff. 25-26.

[73] Class 12 had four orders. Order 2 (Whetstones) was composed of Siliceous Earth and Earth of Alum; Order 3 (Schistic) was made of quartz, mica and shorl; Order 4 (Siliceous) was named after Siliceous Earth. Order 1 (Quadrines) consisted of 'bodies' that were 'disposed in the Earth in Quadrated Masses' and were 'raised in cubical Figures.' These are chemically significant because their cubical shape would have held to be the product of a chemical reaction. As these shapes resembled large crystalline structures, Walker held that they were essentially the result of a bygone chemical process. See his 1760s comments on stone blocks in the Hebrides in the *King's MS*: J. Walker, *The Rev. Dr. John Walker's report on the Hebrides of 1764 and 1771*, M. M. McKay (ed), (Edinburgh: 1980), 112, 215. Pollock (transcriber), *An epitome of natural history vol. VI* (1797), Gen. 708D, f. 30.

[74] Walker's conception of primary and secondary strata will be discussed in the next chapter. *Fossilia maximi; Motis, rupestria; stratosa variis sæpe crassissimus. Indeterdum nodulosa, vaga, soluta; ex Stratis Repibusor disjuncta, strata primitiva, tum secundaria constuunt.* Pollock (transcriber), *An epitome of natural history vol. VI* (1797), Gen. 708D, f. 24.

[75] There were four Orders: 'Ordo I. Terrestria, or Concretions formed from in the Earth. Ordo II. Aquea. Concretions formed in Water. Order III. Ignigena. Concretions formed by Fire; and lastly, Ordo IV. Metallica, Metallic Concretions.' Pollock (transcriber), *An epitome of natural history vol. VI* (1797), Gen. 708D, 114.

[76] Pollock (transcriber), *An epitome of natural history vol. VI* (1797), Gen. 708D, f. 55.

[77] 'It is very evident that this class could never have [a] place in the chemycal System of Fossils, and accordingly we find, that those writers who have attempted to draw up a Chemical System, add the Class of Saxa as a sort of Appendix, which could not be properly arranged in the course of the work.' Pollock (transcriber), *An Epitome of natural history vol. VI* (1797),1 Gen. 708D, ff. 55-56. For instance, at the end of his *Outlines of mineralogy* (1783), Bergman introduces the topic of concreted rocks, but then states: 'Such compositions may well be excluded from the present work, but, upon account of their extensive physical, economical, and metallurgical uses, I propose to give a slight sketch of them.' § 244.

[78] The *OED's* only recorded usage of *substramen* is Rev. James Headrick's *View of the mineralogy, agriculture, manufactures and fisheries of the Island of Arran*... (Edinburgh: 1807), 56.

[79] The *OED's* first geological usage of this word is John Pinkerton's *Petralogy. A treatise on rocks, vol. I* (London: 1811), 530. Walker's usage in 1797 lectures demonstrates that it was clearly being used much earlier. It is most likely that word was imported from its eighteenth-century usage in botany and zoology (which are recorded in the *OED*). Additionally, Walker uses the vernacular equivalent of this word in the *King's MS*. He used it to describe the composition of Porphyry on the Ilsand of Tiree. This means that the term was being used during the 1760s. See J. Walker (1980), 191.

[80] Also used in a geological sense in Rev. John Playfair's *Ilustrations of the Huttonian theory of the earth* (Edinburgh: 1802), 246.

[81] The quotations in the next two paragraphs are taken from Pollock (transcriber), *An epitome of natural history vol. VI* (1797), Gen 708D, ff. 59-63.

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Saxa.

Saxa è tribus constant.	1. Substramen. The Ground. 2. Gluten. The Cement. 3. Concretiones. The Charge.
Substramen. Gluten.	Materia ferruminans.
Concretiones	Materia ferruminata.
Substramen. Copiosum, Concretiones reddit, discretas. Gluten: Parcum, Concretiones reddit contiguas.	Different tantum per majus et minus.

Hinc

1. Saxum Aggregatum	Substramine copioso: Concretionibus discretis.
2. Conglutinatum	Glutine parco: Concre-

Title page for Pollock's Notes on the Saxa Class
David Pollock (transcriber), *Epitome 1797*
EUL Gen 708D, f.59.

their mass. Substramen was 'copious', 'thereby rendering the Concretions at a Distance from one another.' Gluten was 'sparing', thereby making 'the Concretions are near together'.

These three parts were bound together in one of two ways: *compositum* and *supra-compositum*: 'the former is applied to those Rocks in which the Concretions appear to the Eye to be simple, and the latter, to those in which the Concretions are evidently and palpably of a compound Nature.' No matter how they were bound together, the three parts of Saxa Stones produced three different types of compositions: *Saxum Agregatum*, *Saxum Conglutinatum* and *Saxum Conglomeratum*. *Saxum Agregatum* contains a 'copious' amount of substramen and concretions that are distant from each other. *Saxum Conglutinatum* contains a small amount of gluten and has concretions that are closer and more numerous. Finally, the *Saxum Conglomeratum* (which Walker also calls 'Conglomerated Rock'), 'where the Concretions are connected or cemented, without any obvious or visible substramen or Gluten.' These three Saxa compositions form the basis of the two types of strata of the earth (see Plate 5.II again).

This description of how concretions are held together by gluten and substramen bears a strong resemblance to how eighteenth-century walls were constructed from bricks and cement. The probability that Walker saw strata as a mason would see a wall is further supported by the fact that he had several books in his library that focused on the chemical composition of cements. A good example is Brian Higgins' *Experiments and Observations made with the view of improving the art of composing and applying calcareous cements* (1780). Building on 'the chaste and philosophical productions of Dr. Black', Higgins performed experiments that not only had direct application to industry, but also to mineralogy. At one point, he treats both natural and man-made aggregated calcareous bodies as if they shared the same chemical composition.[82] This would make sense because physicians at this time made analogical comparisons between stones taken from out of the ground to stones (calculi) taken out of the human body. Like Higgins' book, the chemical language of Walker's mineralogy lectures is similar to that used in Edinburgh laboratories and suggests that this time period saw no difference between the

[82] Bryan Higgins, *Experiments and observations made with the view of improving the art of composing and applying calcareous cements and of preparing quick-lime: theory of these arts; and specification of the author's cheap and durable cement* (London: 1780). 54-55. Also see Antoine-Joseph Loriot, *A practical essay on a cement, and artificial stone, : justly supposed to be that of the Greeks and Romans, lately re-discovered by Monsieur Loriot, ... translated from the French original, lately published, ...* (London: 1774) EC 203.

calcareous mixtures formed in the earth, by masons or in a laboratory test tube (Plate 5.IV).

Minerals (Classes 15-19)

Walker's last five classes returned to a predominantly artificial method based on inflammable, saline and metallic principles/characters. Class 15 consisted of Salts. The historiographical priority that histories of chemistry often give to the implementation of the new French nomenclature sometimes allows historians to forget that the principle of 'Salts' was alive and well in the eighteenth century. It played an important role in Lavoisier's own intellectual development[83] and even after the turn of the century Aikin's popular *Dictionary of Chemistry and Mineralogy* asserted that: 'The chemistry of salts, taken in the most extended sense, forms by far the largest part of the whole science.'[84] As with Cullen's mid-century definition of Salts,[85] Aikin's *Dictionary* reiterates that they are substances that can be dissolved in water. It then goes on to state that the term 'at present' is 'applied to all the crystallisable acids or alkalis, or earth, or combinations of acids with alkalies, earths or metallic oxyds. Hence the common and useful distinction *alkaline*, *earthy* and *metallic*.'[86]

Although Walker does not cite Aikin in his lectures, his system demonstrates that he combined this later eighteenth-century view with that of the mid part of the century. By the 1790s he held that there were two types of Salt: 'Primary' and 'Secondary'. These two divisions were conceptually similar to the role played by Primary and 'Secondary' Earths. Primary Salts consisted of the acid and alkali principles. These comprised Walker's first two saline orders. He states that acids have five genera and that these 'will require no Explanation, and indeed these more properly belong to the Chymist.'[87] Alkalis had two genera: Natron and Volatile Alkali. Secondary Salts were combinations of Primary Salts with either themselves,

[83] Arthur Donovan, *Antoine Lavoisier* (CUP: 1996). See especially the chapter on Salts.
[84] 'Salt' in A. & C. R. Aikin, *A dictionary of chemistry and mineralogy vol. II* (London: 1807), 284-285. Bergman's chemistry was also heavily based on saline analysis. See his *A dissertation on elective attractions* (London: 1785) and J. A. Schuffle, 'Tobern Bergman, Earth Scientist', *Chymia*, **12** (1967), 56-97, esp. pp. 87-90.
[85] Stated in Chapter II. It should be noted here that William Withering, Cullen's student, included Cullen's definition of 'Salt' in his 1783 translation of Bergman's *Mineralogy*. Withering held Bergman's definition to be inadequate: 'I shall, therefore, offer another, given by Dr. Cullen:—viz. '*Saline bodies* are sapid, miscible with water, and not inflammable.' Bergman (1783), § 20.
[86] A. Aikin and C. R. Aikin (London: 1807), 284-285.
[87] Pollock (transcriber), *An epitome of natural history vol VII* (1797), EUL 709D ff. 13-14. The five genera: Aerial, Vitriolick, Nitrous, Muriatick, Sparry, Boracic and Phosphoric. Walker maintained a firm interest in Salts throughout his whole adult life. In addition to general chemistry books, he read several specialised treatises on the subject. As demonstrated in Chapter II his *Index Librorium* contains several *Philosophical Transaction* articles on Salts. Additionally, Elliot's *Catalogue* contains works that address the manufacture of common salt: N. Grew, *A treatise of the nature and use of the bitter purging sal..* (London: 1697) EC No. 21. J. Collins, *Salt and fishery...* (London: 1682) EC 257; W. Brownrigg, *The art of making common salt...* (London: 1748) EC 565 (This was also recommended by Cullen in 1753). A. Cochrane, *The present state of the manufacture of salt explained...* (London: 1785) EC 493.

Arthur's Seat and Salisbury Crags, c. 1785
John Clerk of Eldin (1728-1812)

G. Y. Craig, *James Hutton's theory of the earth. Reproductions of drawings...* (Edinburgh: 1978), 29.

Based on their chemical knowledge of cements and stones, Walker and his contemporaries most probably likened the earth's strata to bricks and mortar, a point well illustrated by Clerk's representation of the strata in the picture above (see esp. Nos. 4, 5, 7, 9, 11 and point B)

Metals or Earths. These combinations formed the last four orders of Walker's saline classification: neutrals, acid-earths, alkaline-earths and vitriols:

(Primary Salts)	(Secondary/Derivative Salts)
Order 1: Acids	Order 3: Neutrals (Acid + Alkali)
Order 2: Alkalis	Order 4: Acid-Earths (Acid + Earth)
	Order 5: Alkali-Earths (Alkali + Earth)
	Order 6: Vitriols (Acid + Metal)

The first three of his saline orders (acid, alkali and neutral) were the exact divisions taught to Walker by Cullen in 1750s.[88] Similar to Aikin's classification, Walker also included *metallic* Salts (vitriols),[89] and his 'earthy' combinations were both acidic and alkaline. (It must be noted that placing metallic Salts in this acidic category was distinctly different from Walker's 1757 *Philosophical Transactions* paper where he argued that Salt of Iron was *alkaline*).[90]

Walker's classification of Salts was linked to his long-standing interest in mineral waters. In eighteenth-century Scotland, local spas and wells were apopular testing grounds for saline theories that were dually applicable to pharmacology and natural history. The medicinal value of these wells lasted long into the nineteenth century. For instance, the 1797 edition of Cullen's *Clinical Lectures* promoted the pharmacological use of wells that contained 'metallic substances' because of their 'tonic power'.[91] Cullen's book, like many others at the end of the century, utilised saline analysis when testing the composition of such waters. Thus, as a member of the medical faculty, Walker's inclusion of a saline class in his mineralogical system was in tune with contemporary chemical practice. In Edinburgh, saline analysis had also become connected to the study of 'airs', specifically in reference to how water could be impregnated with them. It was probably for this reason that Walker took manuscript notes on Priestley's *Observations on different kinds of air* and Scheele's *Chemical observations and experiments on air and fire* during the 1780s.[92]

[88] William Cullen, 'A Cullen Manuscript of 1753,', Leonard Dobbin (ed), *AS*, **1** (1936), pp. 138-156, on p. 144.
[89] This was an trend at this time. See Bergman on metallic salts in his *Outlines of mineralogy*, (1783) § 20, 24-74. esp. 68-74.
[90] John Walker, 'An account of a new medicinal well, lately discovered near *Moffat*, in *Annandale*, in the county of *Dumfries*. By Mr. *John Walker*, of *borgue*-House, near *Kirkudbright*, in Scotland', *PT*, **50** (1757), 117-147.
[91] William Cullen, *Clinical lectures, delivered in the years 1765 and 1766 ... Taken in short-hand by a gentleman who attended* (London: 1797), 73-74.
[92] For Walker's notes on Priestley, see EUL DC.1.58 f. 44. Joseph Priestley, *Oberservations on different types of air* (London: 1772). There were many editions of this book. The *Catalogue* (EC 99), states that he owned the 1772 edition and his personal notes suggest that he possibly read another edition in 1782. For Walker's notes on Scheele, see EUL DC.1.59 f. 11. Karl Wilhelm Scheele, *Chemical observations and experiments on air and fire. With a prefatory introduction, by Torbern Bergman; translated from the German by J. R. Forster, L.L.D. F.R.S. To which are added notes, by Richard Kirwan* (London: 1780). His notes suggest that he read the book in 1782.

Walker also took mineral water notes from the works of John Elliot (who based his work on Priestley) and Bergman.[93] Indeed the preface to Elliot's book was subtitled 'directions for impregnating water with fixed air' and Walker's notes on Bergman are entitled 'Precipitants for Mineral Waters'. The latter even includes a chart that lists which minerals are present in water taken from the spas at Selzer, Bath and Pyrmont. Correspondingly, Walker's library stocked related works by Baron Montesquieu, Thomas Short, Donald Monro, Alexander Sutherland and William Simpson.[94] He not only used saline analysis in his mineralogy lectures, but throughout all of his other lectures and publications. For instance, he frequently cites saline experiments in his hydrography lectures to demonstrate the chemical composition of the ocean, rain, snow and springs. Note his treatment of 'Hard Water': 'These pit springs will not make a lather with Soap; the reason is that they always either contain an earthy or metallic salt, and hence they decompose the soap by the acid in the saline matter attracting the Alkali of the soap and leaving its oleaginous part disengaged.'[95]

Moving on to another class of Walker's minerals, Inflammables (Class 16) were divided into five orders: Airs, Sulphurs, Bitumens, Coals and Electric[al]. As the concept of an 'aer' touched on various aspects of his mineralogy (especially in relation to aerial acids and mineral waters), Walker's reading of Priestley's *Observations* and Scheele's *Experiments* no doubt influenced his thoughts on the matter. Additionally, many of the chemical mineralogies in his library emphasised an air's ability to decompose exposed stones. 'Air' at this time was also conceptually linked to electricity because the latter was sometimes thought to be a 'fluid' form of energy that used 'air' as a medium. The attention that Walker paid to Coals (Order 4) also had chemical aspects to it. Its very place in his classification system was dependent upon its ability to burn—which, of course, is a chemical quality. Although he did own books that treated the chemistry of coal composition,[96]

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[93] For Walker's notes on Elliot, see EUL DC.1.58 f. 42. These are based on J. Elliot, *An account of the nature and medicinal virtues of the principal mineral waters of Great Britain and Ireland, and those most in repute on the continent* (London: 1781). For his notes on Bergman, see EUL 1.58. f. 40. These are based on Torbern Bergman's *Physical and chemical essays* (London: 1784).

[94] J. B. Secondat, Baron Montesquieu, *Observations de physique et d'histoire naturelle sur les eaux minerales de Dax, de Bagneres ,& de Barege, sur l'influence de la pesanteur de l'air dans la chaleur des liqueurs bouillantes, & dans leur congellation. Histoire de l'electricité, &c* (Paris : 1750) EC 19. T. Short, *General treatise on the different sorts of cold mineral waters in England...* (London: 1766) EC 314; D. Monro, *A treatise on mineral waters* (London: 1770) EC 229.; A. Sutherland, *An attempt to ascertain and extend the virtues of Bath and Bristol waters by experiments and cases...* (London: 1764) EC 294; W. Simpson, *Hydrological essayes: or, a vindication of Hydrologia chymica: being a further discovery of the Scarbrough spaw, and of the right use thereof...* (London: 1670) EC 469.

[95] Walker (1966), 'Hydrography Lecture', 121.

[96] J. Hutton, *Considerations on the nature, quality, and distinctions, of coal and culm* (Edinburgh: 1777) EC 128.

his published letter to Colonel Dirom (1800)[97] demonstrates that he was just as interested in its physical placement in strata.

Walker's three last classes (17-19) dealt with the age-old subject of metals. Aside from the metallurgical references made in his mineralogy lectures (which are not few), his library contained older texts like Agricola's *De Re Metallica* and more recent works like Gellert's *Metallurgic Chymistry* and Jars' *Voyages Métallurgiques*.[98] Other sources for this area would have also been the experiments being conducted by fellow Edinburgh chemists like Joseph Black. In the end, Walker chose to create three 'metallic' based classes. Like the artificial methodology that he used to arrange the Stone classes by their Primary Earth composition, Walker uses six 'primary' Metals as the base of his metallic arrangement: iron, copper, lead, tin, silver and gold. Class 19 arranged these into three orders based on their physical malleability: durable (iron and copper), flexible (lead and tin) and fixed (silver and gold). I have been unable to determine whether or not Walker thought malleability was a chemical attribute. Walker arranged Semi-Metals (Class 18) and Pyrites (Class 17) into orders based on the two 'forms' that were common in eighteenth century chemistry: mineralized and calciformed.[99] The following chart demonstrates how he used the forms named above to create orders in the Semimetallic (Class 18) and Pyrites (Class 17)[100]:

Mundicks (Class 17)		**Semimetals (Class 18)**	
Order 1: Sulphureæ	(mineralized)	Order 1: Sulphureæ	(mineralized)
Order 2: Arsenicals	(mineralized)	Order 2: Arsenicals	(mineralized)
Order 3: Ferrea	(calciformed)	Order 3: Fluida	(?)
Order 4: Amandina	(calciformed)	Order 4: Dubia	(?)

[97] John Walker, *Letter to Colonel Dirom, Quarter Master General of Scotland, on the discovery of Coal* (Edinburgh: 1800). EUL D.S.h.8.15/5. See also John Williams' section on coal in: *The natural history of the mineral kingdom in three parts* (Edinburgh: 1789) EC 279.

[98] G. Agricola, *De re metallica libri XII...* (Basileae: 1657) EC 181. C. E. Gellert, *Metallurgic chymistry. Being a system of mineralogy in general and of all the arts arising from this science*, John Seiferth (trans), (London: 1776) EC 100. G. Jars (the Elder), *Voyages métallurgiques : ou recherches et observations sur les mines & forges de fer...* (Lyon: 1774) EC 514.

[99] For example, see Wallerius' section on metals and semimetals in his *Systema mineralogicum* (Holmiae: 1772). Also see J. R. Partington's comments on this aspect of Wallerius' thought: *A History of chemistry vol. III* (London: 1962), 169-172. Walker defines them as: Calciformed - 'The Form of Calx, which is where the Metal has been reduced from its metallic or reguline State to a Calx by a particular Solvent. The most General Form of this Sort is that of an Ochre.'; Mineralized – 'Where it is combined either with Sulphur or Arsenic'. Pollock (transcriber), *An epitome of natural history vol. VII* (1797), EUL 709D, ff. 155-56.

[100] Traditionally, pyrites (also called mundicks) included rocks that sparked when struck against steel or other hard bodies. See 'Pyrites' article in A. Aikin and C. R. Aikin, (London: 1807). This mineral distinction is used to describe marcasites and spars N. Grew's *Musaeum Regalis Societatis* (London: 1681), which is not on the *Catalogue*, but no doubt would have been available to Walker via one Edinburgh's many libraries.

III. Conclusion

The descriptions of Walker's classes given in this chapter demonstrate that his mineralogy was firmly based on chemistry. In terms of the history of mineralogical classification, this is significant because it demonstrates that Scotland was attuned to ideas that were also being used in Europe, especially in Sweden. It also suggests that the Scots utilised English and French mineralogical systems only if they employed a predominantly artificial methodology. In general, this chapter, admittedly, has been rather densely packed with highly specific information concerning eighteenth-century nomenclature and Walker's mineralogical system. However, since chemistry and mineralogy formed the epistemological foundation for Walker's geology, this explication was a much needed exercise – not only in regard to Edinburgh's Medical School, but also in regard to the standing of the nascent earth sciences in the eighteenth century.

The first section began by outlining the problems often encountered in studies that address early modern nomenclature. It then went on to discuss the chemical characters that Walker used later in his career to create a mineralogical system. Like Wallerius and Bergman, he primarily used these characters to arrange 'Stones' and 'Minerals' into the quintuple taxonomical divisions promoted by Linnaeus (class, order, genus, species and variety). His first major system was created in the early 1780s and throughout the next twenty years, aside from tinkering with it here and there, it remained the same. Having explained the nuances of Walker's method of arrangement, the second section went about the rather arduous, but equally necessary, task of identifying how he actually created the classes of his system. He gave the name 'Stones' to classes 2 to 14. To form the first ten of these, he used an artificial methodology; and for the last three he used a mixed method. Classes 15 to 19 were 'Minerals' and they were arranged based on the primary characters provided by saline, inflammable and metalline principles.

Methodologically speaking, this chapter has also shown that Walker's mineralogical system depended upon two types of taxonomical distinctions: primary and secondary. He applied these to Earths, Salts and Metals. In general, this idea of 'primary' and 'secondary' divisions played a large role in eighteenth-century natural philosophy and their origin and usage has caused much confusion. In fact, further treatment of the use and differing definitions of these distinctions would shed much light on a great many early modern classifications systems.[101] This being the case, it is interesting to note that Walker applies the same hierarchical distinctions to the strata of the earth in his lectures on geology. In doing so, he falls firmly within the mid eighteenth-century practice of dividing strata into three principal classes that were often called primary, secondary and tertiary.[102] This tradition was, interestingly, followed by both artificial (chemical) and natural (external/physical) geological systems. Since Walker's lectures used chemistry to determine the mineralogical composition of geological strata, it would seem that many histories of the earth sciences which have concentrated solely on broadly construed physical theories might be neglecting a vast experimental culture which viewed the earth in stringently empirical terms. Equally, histories of chemistry have also overlooked this culture because its complex five-principle system does not conform to the later historiographical precedent given to Lavoisier and the new nomenclature. It is my hope that this chapter has called attention not only to the relevance of Walker's system, but also to the many other mineralogists who, like him, would have been happy to defer to the hammer and a blow pipe when analysing the 'Mass of Matter in this Globe'.

Additionally, this chapter has raised several other significant points which deserve to be highlighted. First, even though Walker's system became more detailed after he became a professor, its chemical foundation was basically the same as it had been during the 1760s and 1770s. Not only did he arrange stones around the Earth, Salt, Inflammable and Metallic principles, he also modified several of the concepts that Cullen used for mineralogical classification. This shows that the French new chemistry should not be the starting point for historians wishing to examine the local chemical realities which influenced eighteenth-century Scottish mineralogy. Another point that needs to be emphasised is the terms that Walker used for the substances that held Saxa Stones together: gluten, concretion and substramen. These were all firmly linked to chemical experiments being done at the time in the Medical School and beyond (as demonstrated in the discussion given to Higgens' work on cements). Gluten (cement) particularly deserves further notice because its usage was not

[101] A good place to start would be the 'simple' and 'compound' distinctions used by Cullen in the 1750s and Macquer's primary and secondary 'principles' in his *Dictionary of Chemistry* (London: 1777). The former distinction was brought forth into mineralogy via Cullen's conception of a 'simple' and 'structured' stone (as discussed in Chapter 3). Additionally, several eighteenth century chemists, Guglielmin and Bergman for example, used the concept of 'primary' (primitive geometrical form) and 'secondary' to classify crystals. See R. Hookyaas, 'Torbern Bergman's crystal theory', *Lychnos*, (1952), 21-54.

[102] C. Lyell, *Principles of geology or the modern changes of the earth and its inhabitants, 12th edition* (London: 1875), 58-59 (I am intentionally citing this later edition to demonstrate the promulgation of these forms of strata during the *late* nineteenth century). R. Porter, *The making of geology* (Cambridge: 1977) 160-165. A. Geikie, *The founders of geology* (London: 1905) 194-195.

limited to mineralogy. It had actually been imported from its use in medicine, particularly experimental pharmacology, where it was used to describe *biological* substances which held together calculi stones.

As Chapter 4 pointed out, the dual usage of medical and mineralogical terms was not only practiced in Edinburgh, but also throughout Europe. In fact, the early modern period witnessed many mineralogists who attributed a quasi-animate quality to stone on account of their ability to grow on their own.[103] These links to the human body not only affected conceptions of composition – they also analogically suggested that stones could grow at a similar rate to similar substances produced in the human body. In Walker's case, based on Cullen's experiments (and those of other contemporaries), he would have known that the hardened gluten of the calculi could be manufactured by the human body in merely a few years time. This had implicit connotations for how long it would have taken for conglutinated Stones to form. It meant that strata bound together by gluten could have in principle formed quickly and did not necessitate the long time spans hypothesised by theorists like Comte de Buffon. In fact, for a Calvinist Scot like Walker, such a conception of strata formation meant that a biblical time scale was well in line with the experimental chemistry being conducted in the laboratory. This interaction between chemical composition and rates of mineralogical formation is hard to ignore and it dovetails with several comments that I will be making about Walker's conception of geological time in the next chapter.

[103] Porter (1977), 49-50. W. D. I. Rolfe, 'William and John Hunter: breaking the great chain of being', in W.F. Bynum and R. Porter (eds.), *William Hunter and the eighteenth-century medical world* (Cambridge, 1985), 308.

Chapter 6

Geology and the Earths

Introduction

In the previous chapters I have shown that Walker used chemistry to arrange minerals systematically. He used the principles of air, salt, earth, water and fire to create a mineralogical system and to simultaneously promote a rigorous empiricist epistemology and methodology to his students and colleagues. For the most part, his conception of minerals was shared by those in Edinburgh who were members of the Philosophical Society and who taught or studied in the Medical School. The emphasis that his environment placed upon mineralogy and his own interest in the subject had profound effect upon his conception of geology. It is therefore the purpose of this chapter to show how mineralogy worked in conversation with several other factors to shape his conception of the earth's larger structure and composition. Throughout the chapter I will emphasise that his geology was a product of his mineralogy and not vice versa. Indeed, the majority of the authors that he cites in his geology lectures were originally made known to him via his familiarity with systematists—Linnæus, Bergman, Cronstedt, Wallerius and da Costa for example. Additionally, his lectures reference the mineralogical writings of John Ray, John Woodward, John Hill, Louis Bourguet, Johann Reinhold Forster, Johann Ferber, Ignaz von Born and Richard Kirwan (just to name a few).

To excavate the chemical and mineralogical underpinnings of Walker's geology, Section I of the present chapter addresses the empirical nature of Walker's methodology and, subsequently, its underlying epistemological assumptions. I argue that Walker was primarily interested in classifying objects taken from the natural world and that his epistemology did not allow for unverifiable cosmological theories. As a consequence, long periods of time were simply not a suitable topic for responsible scientific discussion. Section II demonstrates that Walker obtained his geological data from chemical, physical and historical 'monuments'. I specifically emphasise how chemistry played an important role in investigating these monuments and how it allowed him to suspend certain types of temporal questions, especially those regarding the age of 'primitive' strata. I end by detailing how his emphasis upon physical and historical monuments encouraged a chronological approach to the earth's age.

I. The Method of Geology

'Omnipotent Power'

At the end of the eighteenth century, there were two prevalent methodologies used to order the data provided by the enterprise of natural history. The first was based upon rigorously descriptive classification systems and is typified by Linnaeus.[1] This taxonomical approach aimed to catalogue all observable properties that would enable other natural philosophers to engage in scientific dialogue that used the same terms and definitions. It was based on the assumption that there was not enough evidence to venture causal explanations and that the underlying order of the world could be ascertained only by carefully cataloguing its contents. The second was theoretical, with Buffon as one of its chief promulgators. It sought to describe and causally explain the properties of and phenomena created by 'natural objects'. As we have seen in the previous chapters, Walker fell into the first category. Accordingly, his conception of the earth was closely linked to his understanding of minerals. This made his geological ideas dependent upon the empirical method of classification that he used in chemical mineralogy. In creating his mineralogical system, it was easy to suspend questions about the earth's age and the specifics of how it was made because his classification of natural (external) or artificial (chemical) characters operated within a non-historical framework. This was not only the case for Walker, but for a great many of his sources.

Walker's main concern, therefore, was to obtain data based on what the object 'is'. Asking what an object 'was' or what it 'could be' were questions saved for the time when nature would be (hopefully) more thoroughly catalogued. This advancement of natural history via the collection of empirical information was supported by most naturalists of the day, including Cullen, who once stated: 'In short, I think everybody acquainted with the progress of natural history must know

* An earlier draft of this chapter was published as M. D. Eddy, 'Merely a Natural History of the Earth: Geology, Mineralogy and Time in John Walker's University of Edinburgh Natural History Lectures', *HS*, **39** (2001), 95-119. I wish to thank D. M. Knight, Roy Porter, David Oldroyd, Andreas-Holger Maehle, John H. Brooke, Gabriel Gohau, Paul B. Wood and Charles W. J. Withers for reading drafts of it . Sections of it were read for the University of Durham Department of Philosophy and the Navigational Aids for the History of Science, Technology and the Environment (NAHSTE) conference held at Edinburgh University Library, 24 November 2000. I would also like to thank the National Library of Scotland, the National Archives of Scotland, Durham University Library and Edinburgh University Library for use of their manuscripts and facilities.

[1] The philosophical foundations and the spread of Linnaeus's system are detailed in F. Stafleu, *Linnaeus and the Linnaeans* (Utrecht:1971); R. Desmond, *Kew: The history of the Royal Botanical Gardens* (London: 1995); A. T. Gage and W. T. Stearn, *A bicentenary history of the Linnean Society of London* (London: 1988).

that the attempts in a system and the study of particulars have mutually promoted and supported each other.'[2] However, because of the incredible amount of data, the prospect of a perfect system did not seem foreseeable in the near future. Since cataloguing and classifying a natural object's *prima-facie* ontological status was the starting point for Walker, the relevance of time and change were inherently suspended within his classificatory methodology. Like Linnaeus, he hoped that artificial taxonomies would one day give way to an underlying true order. This cosmological predisposition stemmed from the belief that such a system was made by a God who was perceived to be 'orderly'. This methodology was therefore inextricably linked to a teleological and epistemological ethos that permeated eighteenth century scientific dialogue. It demonstrated a particularly strong presence in Walker's Enlightenment Edinburgh and therefore needs to be discussed in more detail.

Much has been written on the interaction between eighteenth-century empiricism and natural history. Like many of his Edinburgh contemporaries, Walker's philosophical commitment to the viability of classification was not affected by the writings of David Hume or Immanuel Kant. This was in spite of the fact that he owned the second edition of Hume's *Dialogues Concerning Natural Religion* and a copy of Kant's *Elements of the critical philosophy*.[3] The latter was one of the first translations of Kant's work into English and it was printed too late (1798) to affect the philosophical underpinnings of his classification system. Additionally, the cultural credence in Scotland given to Thomas Reid's 'common sense' philosophy insulated most natural historians and philosophers against Humean scepticism. Even so, it must also be stated that Walker's arrangement of the natural world was not out to prove divine design. He simply took it for granted that God had made the world. This meant that proofs for God's existence were superfluous in a mineralogy lecture (or most of his other lectures for that matter). Thus, even though he owned a copy of Derham's *Physico-Theology*, he only cites its empirical observations.[4] (Ironically, Hume and Derham are listed back to back in Elliot's *Catalogue* of Walker's library). This position between Humean scepticism and natural theology is not unique to

[2] J. Thomson, *Account of the life, lectures, and writings of William Cullen, M.D, vol II* (Edinburgh: 1832), 45.
[3] I. Kant, *Elements of the critical philosophy: containing a concise account of its origin and tendency*... (London, 1798) EC 419. David Hume, *Dialogues concerning natural religion* (London: 1779), EC 324. This was probably the second edition.
[4] W. Derham, *Physico-theology, or, A demonstration of the being and attributes of God*... (London: 1714) EC 324.

Walker and his commitment to arranging the natural 'facts' is present in most of the natural history literature produced by the Scottish Enlightenment.[5]

Walker's methodological approach was under-pinned by the ordered, law-bound, teleological view of the natural world prevalent in Britain during the eighteenth century[6] and particularly strong in Enlightenment Scotland.[7] He believed that natural laws had operated consistently since the formation of the earth. This being the case, he does not stress teleology in his lectures. In fact, there are few references to a divine power. Even though he was an active Presbyterian minister and was elected Moderator of the Church of Scotland in 1790, I have not found any indication that Walker placed strong emphasis on the design argument as promulgated in William Paley's *Natural Theology*.[8] Based on the few references to God in his lectures, it seems that he believed studying the natural world led to a more informed understanding of how God had ordered the world at some unmentioned point in the past: 'From this survey I hope you will be sensible how much this Science is misrepresented, when it is treated as a trivial and unprofitable study. Nothing surely is more adopted to inform the human mind, or more fitted for giving us a just and sublime idea of the *Creator*, or more enlarged views of his perfections and providence.'[9]

During the last five years of his life, Walker wrote down his thoughts about various topics that he deemed important. These papers were then collected in manuscript form and bound under the title of *Occasional Remarks*. On a page with a 1798 watermark, Walker penned an entry entitled 'Theory of the Earth' which states: 'It is my firm persuasion, and not upon Slight grounds, that at some distant period the Earth has undergone changes which could not be the effects of those laws of Nature by which the œconomy of the Terraqueous Globe is at present Regulated. And further that those changes so vast and universal could only be accomplished by the extraordinary interposition of that Omnipotent POWER by which the Globe was at

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5 There were also larger trends in British medicine at the end of the eighteenth century which sought to promote empirical methodologies. See U. Tröhler, '*To improve the evidence of medicine*' (Edinburgh: 2000).

6 The geological contours of this context are outlined in: P. Bowler, *Evolution: The history of an idea* (London: 1989); M. J. S. Rudwick, 'The Shape and Meaning of Earth History' in D. C. Lindberg and R. L. Numbers (eds), *God and nature: Historical essays on the encounter between Christianity and science* (London: 1986) 296-321; J. H. Brooke, *Science and religion: Some historical perspectives*, (Cambridge: 1993), especially Chapter VII, 'Visions of the Past: Religious Belief and the Historical Sciences'.

7 P. B. Wood, 'The Natural History of Man in the Scottish Enlightenment', *HS*, **27** (1989), 89-123, see esp. page 102. These teleological proclivities were often heavily influenced by the 'ordered' conception of nature as promoted by the sixteenth century theologian and reformer J. Calvin in his *Institutes of the Christian religion* (London: 1961).

8 For more on Paley's argument, see M. D. Eddy, 'The Science and Rhetoric of Paley's *Natural Theology*' (*Literature and theology*, in press).

9 T. Birch (transcriber), *1789 Natural history lectures [of Prof. John Walker]*, 'A General View of Its Literary History', EUL Gen. 50, f. 55.

first created.'[10] This is the full extent of the entry and he does not make such a statement in his university lectures. However, he had made a similar remark over thirty years earlier in the *King's MS*. There he briefly mentions a 'great' cause that had aligned the Hebrides.[11] It seems, therefore, that even though he did not publicly discuss his sentiments on the matter, he held that the past history of the globe had experienced a rather turbulent reshaping and that this was caused by divine intervention.

Such an underlying belief formed the foundation of many theories of the earth during the eighteenth century. This was even the case for several of the francophone cosmologists who the Scots thought to be too speculative – two good cases in point being Bourguet's *Lettres Philosophiques sur la Formation des Sels et des Crystaux*[12] and Bertrand's *Mémoires sur la Structure Intérieure de la Terre*.[13] For Walker and his fellow Scots, these cosmologists had gone too far. If the 'period in which the Earth has undergone changes' was 'distant' and operated under a different set of laws, these changes by definition were epistemologically inaccessible. To try and discuss how they had shaped the face of the earth, even if it was from a teleological perspective, strayed too far from empirical evidence. The facts needed to be gathered so that an assessment could be made at a later date. Operating in this mode worked within the framework of a teleological approach while at the same time it placed no restrictions upon the methodology Walker and his colleagues used to classify natural objects. Such a position meant that they had to limit themselves to cataloguing the natural data currently at their disposal.

'Established Facts'

The priority Walker gave to verifiable, empirical facts places him firmly within the Lockean epistemological tradition so characteristic of philosophers during the Scottish Enlightenment and the 'rigorously Baconian, empiricist methodology' that emerged in Britain during the end of the eighteenth century.[14] In his *Essay*

[10] J. Walker, *Occasional remarks by the Revd. Dr. Walker Prof. of Natural History at Edinburgh.* EUL DC.2.40, f. 118.
[11] J. Walker, *The Rev. Dr. John Walker's report on the Hebrides*..., M. M. McKay (ed), (Edinburgh: 1980), 111.
[12] L. Bourguet, *Lettres philosophiques sur la formation des sels et des crystaux, et sur la génération & le mechanisme organique des plantes et des animaux ... Avec un mémoire sur la théorie de la terre* (Amsterdam: 1729). Listed in Walker's 1761 *Index Librorum*, No. 43. Bourguet is also mentioned in Walker's geological lectures (1966), 172 (Scott, however, incorrectly spelled his name as 'Bourguer'). He was a Swiss Calvinist who held that his cosmological theorizing was based firmly upon empirical facts. However, Buffon's use of his work (particularly on the angled nature of mountains) sometimes placed it in a negative light to the English-speaking world. See K. L. Taylor, 'Natural law in eighteenth-century geology: The case of Louis Bourguet', *Actes du XII congres international d'histoire des sciences*, **8** (1974), 72-80.
[13] Élie Bertrand, *Mémoires sur la structure intérieure de la terre. (Lettre sur la diminution des mers et l'origine des montagnes* (Zurich: 1752). Another relevant book written on this matter by Bertrand is *Dictionnaire universel des fossiles propres, et des fossiles accidentels*... (Avignon: 1763) EC 119.
[14] A. L. Donovan, *Philosophical chemistry in the Scottish Enlightenment* (Edinburgh: 1975), 56-62. For Locke's usage of natural history and philosophy, see D. Carey, 'Locke, Travel Literature, and the Natural History of Man', *The SC*, 9 (1996),

Concerning Human Understanding (1689), Locke stated that the human mind is a *tabula rasa* at birth and that external ideas can only originate from empirical stimuli. As an *a posteriori* system, these external ideas were the mental building blocks by which the mind constructed internal ideas. When applied to natural history, this system often gave epistemological priority to the characters of natural objects that could be empirically measured. As the century progressed, Locke's empirical epistemology was harmonised with Newton's *hypotheses non fingo* and Bacon's emphasis upon collecting data. As shown in the previous chapters, it was a highly empirical form of this methodology which guided Scottish chemistry and mineralogy during the *entire* eighteenth century. Even though English, French and German writers diverged from a strict Baconian empiricism during the early to mid part of the century, Scottish writers seem to have been largely immune from the speculative cosmology produced by authors like Buffon, de Maillet, Whitehurst and Whiston. Thus the scientific methodology used by the Scots for natural history favoured personal observation and was suspicious of hypothetical speculation—a situation that is clearly evinced in Black's comments on Buffon's theory of the earth (Plate 6.I).[15]

Arranging data by logical extension into a system was permissible on account of the 'external idea status' of the natural objects that formed the base of the system. As seen in Walker's chemical and mineralogical work, this logical approach to classification was openly recognized to be artificial. He further expressed this sentiment when explaining his method of classification to his students: 'The members of this division are entirely arbitrary; but it is at the same time most commodious. It is here as in true Logic.'[16] This epistemological foundation is important. Walker not only adhered to it when listing the properties of natural objects in the kingdoms of nature, he also used it to describe the properties and phenomena of meteorology ('the atmosphere'), hydrology ('the waters of the Globe') and geology ('the fabric of the Globe').[17] These three divisions detailed 'the natural history of the globe in general as marked by Hippocrates' and constituted the first half of his lectures. The second half treated the 'Imperium Naturæ'. Sandwiched in between these two divisions was a section on methodology. Walker realised that even though his methodology was 'most commodious' for the 'Imperium Naturæ', it

259-280. For the general emergence of empirical geology based on close examination of strata, see R. Porter, 'George Hoggart Toulmin's Theory of Man and the Earth in the Light of the Development of British Geology', *AS*, **35** (1978), 339-352.

[15] For related discussions see: P. B. Wood, 'The Science of Man', in N. Jardine, J. A. Secord and E. C. Spary (eds.), *Cultures of natural history* (Cambridge: 1996) 197-210 and Wood's 'Introduction' in *Thomas Reid on the animate creation*, P. B. Wood (ed), (Edinburgh: 1995); P. R. Sloan's 'Buffon, German Biology, and the Historical Interpretation of Species', *BJHS*, **22** (1979), 109-153 and his 'John Locke, John Ray, and the Problem of the Natural System', *JHB*, **5** (1972), 1-53.

[16] Walker (London: 1966), 'Imperium Naturæ, or Empire of Nature', 220.

[17] *Ibid*, 'Introduction Lecture', 18; 20; 21.

weſtward, ſimilar to that I juſt now deſcribed, is known to exiſt alſo in the Pacific Ocean, and in a part of the Indian Ocean, except where it meets with the coaſt and mountains of Africa, which reverberate it, and give it a turn the other way. By this continual impreſſion of the ſea on the eaſtern coaſts of the continents and iſlands, Mr. Buffon imagined that the ſhores are worn away; the ſea encroaches on them, and by degrees takes poſſeſſion of their place; the materials of them being depoſited at the bottom, either in a horizontal poſition, or formed by the currents and tides into riſings and depreſſions, or long ſubmarine ridges and extenſive valleys, (if they may be ſo called). And thus he imagined the whole face of the globe has been modelled ſome time or other by the action of the water, and retains every where the relics of the productions of the ſea, from which it received its form.

This ſplendid ſyſtem has in ſome parts of it an air of ſublimity and grandeur, eſpecially as it is embelliſhed by the eloquence of Mr. Buffon. But it certainly ſhews a degree of preſumption and temerity in the author of it, which excite in the mind very different emotions from thoſe that ariſe when the phenomena of nature are explained in a ſatisfactory manner, and with ſtrict attention to principles of reaſoning that are well founded and juſt.

The very firſt ſuppoſition in this grand ſyſtem is totally inadmiſſible,—I mean the ſuppoſition that the planets received the projectile motion by means of which they revolve in their orbits, in conſequence of their being daſhed off from the ſurface of the ſun. According to this ſuppoſition, they could have made no more than one very eccentric revolution. As ſoon as by the conſtant action of gravitation, they were made to bend their courſe again towards the ſun, they could not do otherwiſe than to complete the ellipſe, the one half of which they had deſcribed in flying off to their greateſt diſtance; and in completing this elliptic orbit, they muſt neceſſarily have fallen again into the ſurface of the ſun.

Nor is the other part of his ſyſtem, by which he endeavours to ac-

Black on Buffon's Theory of the Earth

Joseph Black, *Lectures on the elements of chemistry, vol. 2* (Edinburgh: 1803).

could not accommodate all of the empirical data included in the Hippocratean lectures. For this reason, the latter lectures were governed by the Scottish version of Lockean epistemology outlined above. This meant that he was keen to detail observable properties and phenomena. For instance, when discussing the ocean, he gave figures on the height of tides, salinity, temperature and depth.

Such an empirical approach to the Hippocratean topics proved to be more complex when addressing occurrences like disappearing springs, typhoons, whirlpools and waterspouts—things that almost necessitated a basic causal explanation. When discussing such phenomena, Walker takes care to list the empirical 'characters' available to him. Note his statement about springs: 'In order to form any idea of the cause of springs we must take a view of their phenomena, and of the established facts we possess in their history.'[18] This quotation reveals a critical point to be made about his Hippocratean lectures. Once he has finished describing the known characters of a certain phenomenon or property, he does not make any conjecture about causation unless he believes the facts logically warrant such a conclusion. This position was most probably engendered by late eighteenth-century British reaction against the many theories of the earth that had sprung up earlier in the century – a situation which, as Neve and Porter put it, obliged natural philosophers 'to polemicize directly for or against particular theories, or at least to think within the concept and expectations created by the previous generation of theories.'[19] Thus, if there was a deficiency of facts, Walker simply ended the discussion and moved on to the next topic. Because of this epistemological commitment, his Hippocratean lectures are replete with statements like: 'This subject would well deserve our notice did it afford us any necessary and well ascertained facts, which however unhappily it does not'[20] or 'But these are merely theoretical suppositions which we do not understand and for which there is no foundation.'[21]

'System Mongers'

Walker's epistemological convictions created an immense gulf between systems of logical extension and theories of the earth that were too large to be supported by empirical evidence: 'I would not wish to be thought to deliver any thing like a Theory, but merely a natural history of the earth.'[22] Such an aversion to theory

[18] *Ibid.*, 'Hydrography Lectures', 150.
[19] M. Neve and R. Porter, 'Alexander Catcott: Glory and Geology', *BJHS*, **34** (1977), 37-60. Quotation taken from page 41.
[20] Walker (London: 1966), 'Meteorology Lectures', 71
[21] *Ibid.*, 'Meteorology Lectures', 113
[22] *Ibid.*, 'Geology Lectures', 180.

effectively negated the possibility of proposing a hypothesis that included long spans of time and change. In this empirical tradition, one of the most common rhetorical tools used to discredit an opponent's argument was to label him a 'theorist'. For instance, in his *An Examination of Dr. Burnet's theory of the earth*, John Keill, levied such a charge against Thomas Burnet's position on the formation of the earth's outer crust: 'After this fashion has the Theorist [Burnet] formed his Antediluvian habitable world, which doth not much differ from the *Cartesian* method of making the earth, only *Des Cartes*, being somewhat wiser than the Theorist, would not allow the outward crust...'.[23] Keill was keen to attack Burnet's theory because he held that Burnet's method did not utilise 'the acknowledged principles of natural philosophy', that is, there was not enough empirical proof (neither from scripture nor nature) given to support Burnet's conclusions. Thus what Burnet thought to be reasonable, Keill (a self-avowed Newtonian empiricist) thought to be theoretical.

In a similar vein, Walker was influenced by the Scottish version of Newtonian empiricism as filtered through the analytic methodology taught to him by Cullen. In a letter written from his home in Moffat on 29 February 1776, Walker once summed up his opinion of theorists to his patron Lord Kames: 'I perfectly agree with your Lordship, concerning the bulk of the French and German writers. I know how liable they are to run to the excess of riot... In Germany the human understanding is not yet perfectly enlightened in respect to Nature... The errors of the French proceed not so much from the country as the people.' He then goes on to emphasise his dissatisfaction with French cosmology: 'Those very qualities which make them shine in other parts of literature, make them bad theorists. From Des Cartes down to Buffon, France has certainly produced the worst system mongers that ever put pen to paper, and more of them, too, than any other country.'[24] This disrespect for French theorists even allowed Walker and his Edinburgh contemporaries to discredit the 'system mongers' who wanted to use their method to prove the existence of God. For instance, both Walker and Cullen criticised Maupertuis's *Essai de Cosmologie* (1751) for its theoretical approach.[25] This

[23] Walker's library contained John Keill's *An examination of Dr. Burnet's Theory of the earth, together with some remarks on Mr. Whiston's New theory of the earth* (Oxford: 1698) EC 463. The above quotation was taken from the 1734 (London) edition, page 31. Keill was particularly unhappy with the Burnetian school of diluvianism because he felt that 'the flood-makers have given the Atheists and Argument to uphold their cause', p. 18. Walker's library also included John Beaumont's *Considerations on a book, entitled The theory of the earth, publisht. by the learned Dr. Burnet* (London: 1693) EC 355, and W. Worthington's, *Thes scripture theory of the earth throughout all its revolutions, etc.* (London: 1773) EC 403.
[24] Both quotations take from NAS GD24/1/571/164-170. Printed in A. F. Tytler, *Memoirs of the life and writings of the Honourable Henry Home of Kames... Vols. 1 & 2* (Edinburgh: 1807), Appendix No. II, 56-66.
[25] Pierre Louis Moreau de Maupertuis, *Essay de cosmologie* (Leiden: 1751). Walker (1966), 'Geology Lectures', 89, 216. When reviewing the book for the Philosophical Society, Cullen did not mince his opinion: 'The work is partly metaphysical

sentiment was not just applied to writers who lived across the English Channel. Walker also had stern words for the theories advanced by English writers, particularly William Whiston's *A new theory of the earth* and John Whitehurst's *An inquiry into the original state of the earth.*[26] This being the case, it is worth noting that Walker's geology lectures ignore James Hutton's 1785 paper which addressed the formation of the earth's crust. This could be attributed to the fact that Hutton used the same form of chemistry as Black (who had based much of his mineralogically related work on Bergman's chemical-mineralogy)[27] or to the possibility that Walker was a bit less harsh on people that he actually had met in person.[28]

Nowhere is Walker's aversion to 'system mongers' more apparent than in his treatment of Buffon in his geology lectures. For Walker, Buffon's cosmology typified two things that most irritated him: (1) unconfirmed, and therefore potentially erroneous, information and (2) a love for theoretical systems. This irritation was no doubt linked to Walker's training in the Medical School and reinforced by the analytic methodology of the five-principle chemistry that he practiced. His disapproval of theoretical cosmology can be clearly seen in his treatment of Buffon's *Histoire Naturelle*. In addition to virtually ignoring Buffon's theory of the earth, he is fond of citing Buffon's empirical mistakes.[29] For instance, in his discussion of climate, Walker asserts that the northern hemisphere is warmer than the southern. He then writes: 'This opinion however has been lately combated by Buffon who affirms that the Southern hemisphere is equally warm with the North. I shall now enumerate those instances which throw sufficient light on the subject to shew that Buffon's opinion was a mistake; and first I shall mention these authenticated facts with regard to the Southern hemisphere which we owe chiefly to the late circumnavigators.'[30] Note that he is interested only in the 'authenticated facts', a statement that clearly

partly mathematical; in either respect it falls improperly under my cognizance, and works of this kind I shall hereafter put into other hands.' J. Thomson (1832), Vol. I,138.

[26] See W. Whiston, *A new theory of the earth, from its original, to the consummation of all things. Wherein the creation of the world in six days, the universal deluge, and the general conflagration, as laid down in the Holy Scriptures, are shewn to be perfectly agreeable to reason and philosophy....* (London: 1696) EC 290; J. Whitehurst, *An inquiry into the original state and formation of the earth; deduced from facts and the laws of nature...* (London: 1778) EC 433.

[27] H. D. Hedborg, 'The influence of Torbern Bergman (1735-1784) on stratigraphy: A Résumé', in C. J. Schneer (ed.), *Toward a history of geology* (London: 1969), 186-191.

[28] Hutton's 1785 paper laid the foundation for what would become his *Theory of the earth with proofs and illustrations* (Edinburgh: 1795). As physical secretary of the newly formed Royal Society of Edinburgh, Walker would have been responsible for reading the paper. Even if by some strange chance he did not read it in 1785, his library contains a copy of it. See James Hutton, *Abstract of a dissertation read in the Royal Society of Edinburgh ... April, 1785, concerning the system of the earth, its duration and stability* (Edinburgh: 1785). EC 371. Additionally, shortly before Walker died, he purchased J. Murray's *A comparative view of the Huttonian and Neptunian systems of geology* (Edinburgh: 1802) EC 287.

[29] Even though Buffon sought to base *Histoire naturelle* upon the known empirical 'facts', his theoretical sections were generally subject to much criticism within the Scottish context. P. B. Wood, 'Buffon's Reception in Scotland: the Aberdeen Connection', *AS*, 64 (1987), 169-190. Also see Walker's treatment of Buffon in when he discusses subterranean heat in his 'Geology Lectures', 200-201.

[30] Walker (London: 1966), 'Meteorology Lectures', 116..

insinuates that Buffon, on this matter at least, was not utilizing confirmed information.[31] Interestingly, there are some instances where Buffon is not criticised. One is in the 'Mountains' section of his geology lectures where he discusses the angles of mountain tops in parallel mountain ranges. He states that Buffon's 'System', in accordance to the known empirical facts about mountain top angles, correctly assumes that the tops of the Alps had been formed by water.[32] Utilizing Buffon in such a manner demonstrates that he viewed Buffon's multi-volumed works as nothing more than source books for empirical observations.[33] Although he likes to single out Buffon, he follows a similar approach to other sources which used erroneous information or which propose theories based on unconfirmed data. At one point or another, he disagrees with almost every author that he cites.

II. Geological 'Monuments' of Time

Preliminary Considerations

In a section entitled 'Desiderata' in his 41st Natural History lecture given during an academic year in the 1790s, Walker briefly asks two questions regarding the age of the earth: '1.st Of what year to fix its formation. 2.nd How far its Chronology can be ascertained by the physical data, for these are very probably certain monuments by which we may Judge of this matter.'[34] This is one of the few places where he poses such questions and his treatment of them is brief. Unsurprisingly, he does not venture to answer the first question. The second question is strictly concerned with tracing 'Chronology', i.e., a linear progression of events that can be directly linked to empirical evidence. In light of the statistical mindset that dominates many of the natural sciences nowadays, this approach might seem a bit foreign. But up to the beginning of the nineteenth century, conceptions of the earth's age were largely based on the same timescales that had developed within the field of civil history. Because of their fidelity to textual precedents, these histories were seen as a highly empirical enterprise. It was therefore not uncommon to find chorographies and travel accounts which blended civil and natural history into one narrative. Thus, during the eighteenth century, the modern day fields of

[31] Sloan addresses Buffon's epistemology in his aforementioned article (1979). See also his 'The Buffon-Linnaeus Controversy', *Isis* (1976), **67**, 356-375 and 'Buffon Studies Today', *HS*, **32** (1994), 469-477.
[32] Walker (London: 1966), 'Geology Lectures', 172. For Buffon's comments on this topic see Proofs Article IX, 'Of the Inequalities upon the Earth's Surface' in his *Histoire naturelle*.
[33] This was generally how Buffon's work was viewed by the 'new generation of naturalists' during the last decades of the eighteenth century. M. J. S. Rudwick, *The meaning of fossils* (London: 1972), 93-95.
[34] [Anon?] (transcriber), *Lectures on natural history, vol. IV* (1790s) EUL DC.2.19, f. 3.

archaeology, palaeontology, geology, mineralogy, theology and classics were most often placed within the timescales offered by civil and ecclesiastical histories. Mineralogy often played a pivotal role in linking up these emerging fields because not only did it attempt to classify fossilised organic remains, it also tried to find precedent for such objects in classical works and in natural histories of other countries.

In answering the 'Chronology' question posed above, Walker gives four 'monuments' to aid his students in tracing the earth's 'Chronology': the 'Saltness' of the ocean, beds of peat moss, 'extraneous fossils' and the population and progress of mankind. As Rappaport has noted, this usage of geological 'monuments' was quite common during this time period: 'Most historians of geology are aware that early naturalists often referred to fossils as "medals" of the Flood, that the term "monument" was frequently applied to both rocks and fossils, and that even such words as "documents" and "archives" had some currency in geological contexts.'[35] Indeed, Jean André de Luc,[36] a source for Walker's lectures, readily employed the term 'monuments' in his work: 'In the *Elementary Treatise of Geology* lately published, I have set forth and discussed all the fundamental points of natural philosophy and natural history which concern the *History of the Earth*, presenting them in such a manner as I thought most proper for clearly pointing out the most essential *monuments* of that history.'[37] When examining Walker's comments about his four monuments in other parts of his lectures, it becomes apparent that he believed the evidence they offered about the earth's age was either inconclusive or could only support a chronology that did not exceed a few thousand years. He had based such conclusions on data generated by a natural object's artificial (chemical) and natural characters and the chronologies found in historical records. The following sections investigate how these sources of data in combination with the general strictures of his methodology and epistemology influenced his conception of the earth's structure.

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[35] R. Rappaport, 'Borrowed words: Problems of vocabulary in Eighteenth-Century Geology', *BJHS* (1982), **15**, 1. The practice was continued up into the nineteenth-century. See M. J. S. Rudwick, 'Transposed concepts from the humans sciences in the early work of Charles Lyell', , L. J. Jordanova, R. S. Porter (eds), in *Images of the earth* (Chalfont St. Gilles: 1979), 67-83.
[36] Davies has asserted that de Luc was 'the most widely experience British geologist of his day'. G. L. Davies, *The earth in decay* (London: 1969) 137.
[37] The italics are de Luc's: *Geological travels* (London: 1810) 1. Also see his *An elementary treatise on geology: determining fundamental points in that science, and containing an examination of some modern geological systems, and particularly of the Huttonian theory of the earth*, Henry De La Fite (trans), (London, 1809). This was an English edition of work that de Luc had written during the 1770s through the 1790s. Walker mentions de Luc's name in his lectures, but does no state his source.

Character Chemicus and 'Monuments' of Chronology

Just under four decades ago, Rappaport echoed the work of Hooykaas in calling for studies which sought to address the underestimated impact that mineralogical classification had upon nascent eighteenth-century 'geology'. She stated: 'Research into this area might well begin with a survey of the systems of such influential writers as Wallerius, Cronstedt, Bergman, Werner, and others, with emphasis upon the place each mineralogist assigned to minerals and rocks important to the geologist.'[38] Because Werner's work is more similar to modern conceptions of geology, his mineralogical writings have received some recent attention from historians (although it must be said that these works usually treat Werner's ideas in relation to how they influenced the nineteenth century and not how they were actually understood by his contemporaries – especially those who were chemists). However, aside from the works of Laudan and Oldroyd, little research has been done to demonstrate how the chemical mineralogy of Wallerius, Cronstedt and Bergman influenced geology.[39] Since Walker's mineralogy was closely based on the works of these three Swedes, his geology lectures provide an excellent source for examining the influence that chemical mineralogy had upon geology.

At the end of the eighteenth century, most chemical mineralogists held that minerals and stones were formed by concretion, congelation, crystallization and petrification—processes which necessitated an aqueous medium. Additionally, the layered nature of strata (particularly secondary strata) only hinted further at the existence of a large inundation of water. This led many, mineralogists and theorists alike, to believe that scientific evidence and the accounts of ancient texts pointed to a deluge that had happened in the past. Unlike many early modern cosmologies that sometimes inserted empirical evidence into broadly encompassing mechanical theories, the diluvialism of later eighteenth-century chemical cosmologists was based upon laboratory and field experiments that were usually based upon five-principle chemistry. These seemed to indicate a flood was the most empirically sustainable option to be used when explaining the surface of the earth[40] (a point that is often lost on account of the attention that histories of chemistry give to pneumatic, as apposed to saline, testing methods).[41] This perceived need for an aqueous medium in the

Walker (1966), 'Geology Lectures', 167. For more on de Luc's geological views at this time, see his *Lettres physiques et morales sur l'histoire de la terre et de l'homme* (The Hague : 1779-80).

[38] Rapport (1964), 69.

[39] Porter (1977) and Gillispie briefly touch upon this issue. C. C. Gillispie, *Genesis and geology : a study in the relations of scientific thought, natural theology, a nd social opinion in Great Britain, 1790-1850* (Cambridge, Mass: 1996).

[40] R. Laudan, *From mineralogy to geology* (London: 1987), 62-69.

[41] Much attention is given to gases because of their role in establishing the new French nomenclature. However, Bergman felt that the real progress in nomenclature was to be found in aqueous liquids (salts and their affinities) not aerial ones. It was for

chemical and physical formation of strata also harmonized well with the concept of a universal flood propounded in the Bible. Because of the context, it should not be surprising to learn that Walker's personal library had no shortage of books on this topic.[42] Many of these works, Scheuchzer's for example, were standard sources for most eighteenth-century naturalists.[43]

The fact that the earth might have once been an aqueous solution made it very easy for chemists to draw analogical similarities between the flood and the saline experiments that they were conducting in the laboratory. This particularly would have been the case in Enlightenment Edinburgh because its scientific community was strongly influenced by the chemists who taught in the Medical School (especially William Cullen and Joseph Black). A good example of how 'humid' chemical analysis formed an epistemological foundation for his treatment of the earth's chronology can be seen in Walker's discussion of ocean salinity levels. In his hydrography lectures he introduces the topic of 'whether the saltness of the sea was coeval with the globe? or whether it is only a work of time?'.[44] This use of salinity levels to determine the age of the world had been made popular by Edmond Halley during the early eighteenth century.[45] Assuming that the sea was originally composed purely of fresh water, Halley argued that the increase of the sea's salinity could be used to calculate the earth's age.

Using the basic method of Halley's argument,[46] Walker's hydrology lectures cite several examples to demonstrate that, 'no fact has been brought to prove that the Saltness of the oceans has increased any degree.' This assertion meant that the sea was not very old and it opposed the equally well-known position of Robert Boyle who held that the sea had gained salt from 'Rains, Rivers and other Waters.'[47] To prove that the ocean did not obtain its salinity from rivers, Walker states that since river water is 1/4000 part sea salt, it would take 6400 years for the ocean to reach a

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this reason that he left pneumatic chemistry to Scheele, who was his assistant. See M. Beretta, 'Torbern Bergman in France: An unpublished letter by Lavoisier to Guyton de Morveau', *Lychnos* (1992), 167-170. For a detailed view of Bergman's chemical testing methods see D. Oldroyd, 'Some Eighteenth Century Methods for the Chemical Analysis of Minerals', *JCE*, **50** (1973), 337-340.

[42] For a background of diluvialism, see R. Huggett, *Cataclysms and earth history: The development of diluvialism* (Oxford: 1989). Some of Walker's books on this topic were: J. J. Scheuchzeri, *Herbarium diluvianum* (Lugduni Batavorum: 1723); G. A. Scopoli, *De Hydrargyro Idriensi tentamina physico-chymico-medica* ... (Lipsiæ: 1771) EC 486 (British Library has the only extant edition in the UK); A. Calcott, *A treatise on the deluge* (London: 1768) EC 322.

[43] Melvin E. John, 'Some Notes on Dr. Scheuchzer and on *Homo diluvii testis*', in Schneer (1969), 192-213.

[44] All quotations from Walker in this paragraph are taken from his 'Hydrography Lectures', Walker (1966), 128-130.

[45] E. Halley, 'A short Account of the Cause of Saltness of the Ocean, and of several lakes that emit no Rivers; with a proposal, by help thereof, to discover the Age of the World', *PT*, **29** (1715), 296-300. Like most of his references, Walker only cites Halley's argument and not the printed source. This work is briefly addressed in Rudwick (1972), p. 93. This system would be used again by John Joly in 1899.

[46] Halley (1715), 300, 299. Halley's article was actually written to clear himself of allegations that accused him of denying the finite age of the world. Even though he says that further evidence might demonstrate the earth to be 'older than many have hitherto imagined', he candidly admits the argument is of no practical use because it requires 'great Intervals of time to come to our Conclusion.' This is treated in A. Cook, *Edmond Halley* (Oxford: 1998).

level of 1/500. However, avers Walker, 'we know that the waters of the Sea contain in many cases 1/30 part of salt.' Since this statement was offered as a counter example, it clearly indicates that he did not accept the long time span needed for the rivers to supply the salt that would allow the ocean to reach its current salinity level. Furthermore, he did not believe in riverbed erosion, which was a necessary factor if such a large amount of salt was to be washed into the sea.[48]

Since chemistry shaped the methodological and empirical foundation of Walker's mineralogy, it also affected his conception of geological strata. As we learned in the last chapter, he divided strata into three principal classes that were often called primary, secondary and tertiary. In doing this, he fell firmly within mid eighteenth-century proto-geological practices which were, interestingly, followed by both theoretically and empirically based geological systems.[49] However, while someone like Bertrand sought to explain how mountains arose from these layers,[50] Walker was a bit more cautious on such speculations.[51] For chemical mineralogists like Bergman and Walker, this threefold division was based upon the Primary Earths and Secondary (derivative) Earths that they used to create the classes of their mineralogical systems (as discussed in Chapter 5).[52] For Walker, primary strata were considered to be 'primary' because 1) they contained high concentrations of indurated Primary Earths[53] and 2) the presence of *Saxum Conglomeratum* and *Saxum Conglutinatum*—the latter requirement being most clearly explained in mineralogical lectures on Saxa Rocks.[54] This composition in combination with the lack of plant or animal remains and the possibility of both horizontal and vertical inclines convinced

[47] This being the case, Boyle still held that the 'access of salt' gained from these sources was quite small. Robert Boyle, *Tracts consisting of observations about the saltness of the sea...* (London: 1673/4) EC 136, 22.

[48] Regarding the salinity test, W. Smellie's 1771 edition of *Encyclopœdia britannica* states: 'With regard to the saltness of the sea-water, it is very rationally judged to arise from great multitudes both of mines and mountains of salt, dispersed here and there in the depths of the sea. Dr. Halley supposes that it is probable the greatest part of the sea-salt, and of all salt lakes... is derived from the water of the rivers which they receive.' *Encyclopœdia britannica... Vol. III.*, (Edinburgh: 1771) 572. Citing Halley, Buffon asserts the same positions in his 'Of Rivers' chapter in *Natural History* (1828), 71.

[49] Humphry Davy also used the same divisions, *Elements of agricultural chemistry...* (London: 1813), 167-179. This book was based on lectures where he also used statigraphical alignment: *Humphry Davy on geology: The 1805 lectures for the general audience*, R. Siegfried and R. H. Dott (eds), (Madison: 1980). Additionally, see C. Lyell, *Principles of geology or the modern changes of the earth and its inhabitants* (London: 1875), 58-59. R. Porter, *The making of geology* (Cambridge: 1977) 160-165. A. Geikie, *The founders of geology* (London: 1905) 194-195.

[50] Bertrand held that there were three 'classes' of strata, the first being a 'primitive' layer that functioned as a 'universal bottom'. Carozzi and Carozzi (1984). 271-275.

[51] Bergman followed a similarly cautious approach. His three layers were called *Uråldrige* (Primitive), *Floågrige* (Secondary) and *Hopvräkta* (Tertiary). Hedberg (1969), 187-188.

[52] For earlier discussions concerning the division of strata, see N. Steno (Niels Stensen), *The earliest geological treatise (1667)...* Axel Garboe (ed), (London: 1958); A. L. Moro, *De' crostacei e degli altri marini corpi che si truovano su' monti* (Venezia:1740).

[53] Based on his mineralogy lectures, Walker probably thought that the chemical affinities of the stones in primary strata were stronger than those which were in the stones of secondary strata. Such a hierarchy would have been analogous to the arrangement of mineralogical substances on Bergman's affinity table. Since Walker does not directly address how elective affinity influenced mineral composition, future studies will need to explore this issue in relation to other writers who are in his canon. A good starting point for this investigation would be R. Hookyaas, 'The conepts of "individual" and "species" in chemistry', *Centaurus*, **5** (1958), 307-322.

[54] His lectures on Saxa Rocks state that, '*Primitiva Stratis*' is '*verticalibus disposita: extraneorum expertia.* Primative Rocks. Mountains Rocks.' The Saxa section is most clearly treated in Pollock (transcriber), *An epitome of natural history vol. VI* (1797), Gen 708D, ff. 59-63.

Walker that primary strata were the oldest of the three classes. Mountains composed of primary strata were therefore the most ancient and were called Primary, or Primitive, Mountains.[55] Primary strata and mountains were the core upon which all other geological formations were built.[56] Even after Walker died, this conception of primary strata and mountains was promoted by leading chemists like Humphry Davy (Plate 6.II).

In his mineralogy lectures Walker taught his students that the most abundant stone found in primary strata was Saxa Stone (Class 13). Even though he does not explicitly state it, Walker's sections on these stones demonstrate that he probably thought that they were formed in a chemical soup that existed at some point in the past. Earlier in the century, this chemical solution was often equated with the original chaos that Genesis states to have existed before the world took a recognisable shape.[57] Many of Walker's sources address this topic. Whitehust called this chemical solution a 'universal *dissolvent principle*'[58] and John Ray held that, 'By the word *chaos* the Ancients understood a huge Mass of Heterogeneous Bodies, or the Principles and Seeds of natural Bodies confusedly and disorderly mingled together in one lump.'[59] Additionally, Robert Jameson (Walker's protégé and Edinburgh's next Professor of Natural History) voiced a similar position in 1802:

> *The primitive rocks, of which granite is the oldest, were formed during that period which Werner terms the* chaotic, *when the earth was still covered to a great height with water, and before organization had commenced. Their structure shews that they have been deposited from a state of chemical solution, and the diminishing of the newer strata, that the water has sunk gradually and calmly.*[60]

For Walker, this primitive chemical solution was, however, different from the biblical deluge and seems to have been subject to the slightly different laws of nature that he believed to be in operation in the 'distant period' mentioned in *Occasional*

[55] Walker often uses the words 'primary' and 'primitive' interchangeably. He states that primary mountains mainly consisted of quartz, feldspar, jasper, soap-rock, lapis olaris (soap stone), amianthus (white asbestos), asbestos, slate, touch stone (black jasper), porphyry, serpentine, granite, whin rock and basalts—all of these being composed of schorl and mica. Walker (1966), 'Geology Lectures', 174.

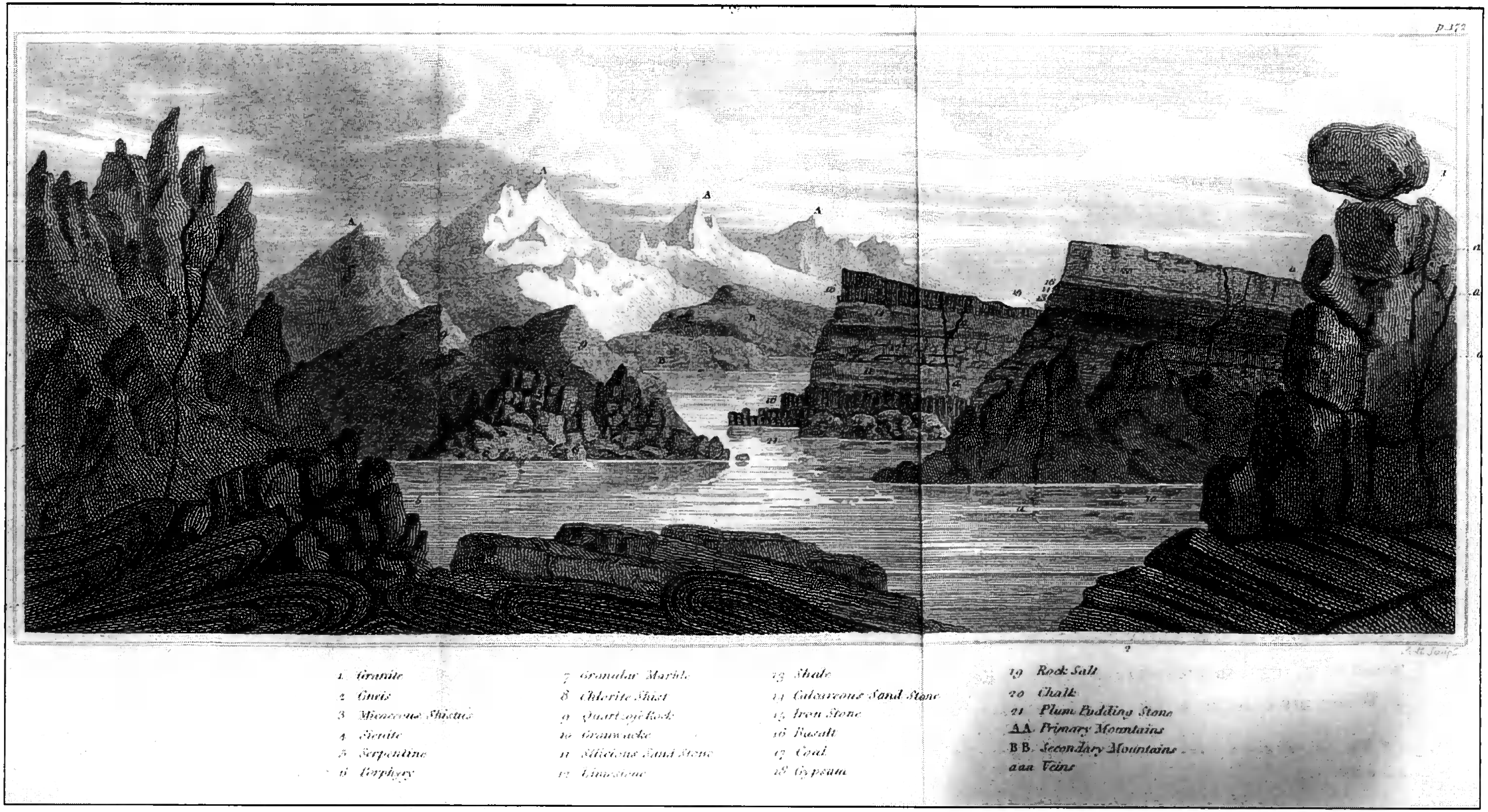
[56] Walker's library also contained: J. Pringle, *A discourse on the attraction of mountains, delivered at the anniversary meeting of the Royal Society, November 30, 1775* (London: 1775) EC 166; P. S. Pallas, *Observations sur la formation des montagnes....* (St. Pétersbourg: 1779) EC 223 (Even though this went through at least four editions, the only extant copy UK copy of it is in the British Library).

[57] This concept of stone formation via liquid solidification was conceptually similar to 'chemical effluvia' that many early modern mineralogists thought was responsible for forming metals and other types of minerals in situ. This area deserves much more attention. For a brief commentary on Boyle's position on this topic, see B. Kaplan, *"Divulging of useful truths in physick": the medical agenda of Robert Boyle* (Baltimore: 1993), 111.

[58] Whitehurst (1778), 9. Davies (1969), page 142, calls it a 'primordial fluid'

[59] J. Ray. *Miscellaneous discourses concerning the dissolution and changes of the world. Wherein the primitive chaos and creation, the general deluge, fountains, formed stones, sea-shells found in the earth, subterraneous trees, mountains, earthquakes, vulcanoes, the universal conflagration and future state, are largely discussed and examined* (London: 1692) EC 466, 151.

[60] Robert Jameson, 'On Granite', *A journal of natural philosophy, chemistry, and the arts*, **2** (1802), 225-233. Quotation taken from page 225. The prevalence and influence of this chemical solution is frequently ignored by historians because it is viewed through the Neptunian and Vulcanism debates that are most often used to categorise late eighteenth-century mineralogists.



Humphry Davy's Geological Strata

Humphry Davy, *Elements of Agriculture* (London: 1813), Figure 16. Note his Primary and his Secondary Strata distinctions

Remarks.[61] This chemical bifurcation of aqueous upheavals is consistent with the general intellectual climate in both Sweden and Britain at this time.[62] Such an approach made it easier to accommodate both five-principle chemistry and the biblical narrative with the ever-growing pile of data generated by late eighteenth-century empiricism.

Walker's secondary strata were looser consolidations of Primary Earths which were formed by a deluge (which Walker does not attempt to link to the Noachian flood). He knew quite a bit about the chemical composition of this strata because if was the source of the classes (2 – 11) which formed the largest part of his own mineralogical system. Secondary strata were also based on a horizontal incline and contained organic remains.[63] Mountains composed of secondary strata were called secondary mountains.[64] Since stones from secondary strata included recombined fragments of primary strata, their composition was more chemically heterogeneous or fissile. However, even though Walker intimates that they were formed in an aqueous solution, he cites examples to demonstrate that this process could not have been guided by specific gravity. Based on his implicit acceptance of Bergman's affinity tables, it might be possible that he thought these attractions somehow influenced the formation of secondary strata.[65]

Chemical analysis of the minerals contained within the primary and secondary strata did present some restrictions upon studying the relevance played by time in their formation. At the base of Walker's chemistry were the Primary Earths. These by definition were impervious to temporal questions. Furthermore, chemistry could only determine composition. Ascertaining how Primary Earths actually became minerals was more difficult and subject to criticism. Based on the chemical data, Walker asserted that secondary strata had been formed by water. The chemistry

[61] The only extensive treatment of this fluid that I have been able to find in secondary literature is in (Davies: 1969), pp. 142-144, who merely summarises Richard Kirwan's position on the matter.

[62] Rappaport (1978), 14. Bergman also held that large inundation of water was responsible for strata formation – however, he was loath to equate this inundation with the Biblical flood. See his Tobern Bergman, *Physisk Beskrifning ofver Jord-Klotet, På cosmographiska Sållskapets vågnar, förfallad* (Uppsala: 1766). This was translated into German in 1769 as *Physicalische Beschreibung der Erdkugel... aus dem Schwedische*, Lampert Hinrich Röhl (trans), (Greifswald: Röse, 1769). This German version went through several editions. Aside from trying to portray Bergman as a proto Carl Popper, J. A. Schufle's discussion of Bergman's concept of the flood and providence are of note in 'Ariadne's thread: scientific criticism versus philosophical criticism', *New Mexico journal of science*, **19** (1979), 23-35.

[63] Walker also hints that secondary strata could possible be composed of *Saxa Agregatum* because he includes the following statement in his Saxa Stone lectures: *Secundaria Stratis depressis disposita: Matrices Extraneorum*. Secondary Rocks. Horizontal Covers.' Pollock (transcriber), *An epitome of natural history vol. VI* (1797), Gen 708D, ff. 59-63.

[64] Walker states that secondary mountains mainly consist of limestone, shell marle, marble, portland stone, alabaster, gypsum, ironstone, sandstone, mill stone and coal. Walker (1966), 'Geology Lectures', 174. Sometimes, he used his knowledge of stratigraphical divisions to give both scientific and economic advice. Writing to the Quarter Master of Scotland in 1800, he asserted: 'In searching for Coal, especially in Scotland, a proper knowledge of the distinction between PRIMITIVE and SECONDARY strata is highly necessary.' J Walker, *Letter to Colonel Dirom, Quarter Master of Scotland, on the discovery of coal* (Edinburgh: 1800), 4.

[65] It may be possible that he did not specifically address this issue because several eighteenth-century 'theorists' liked to use chemical affinity for their own devices. For instance, Whitehurst (1778), used the principles of 'conformity' and 'affinity' in

behind this assertion was informed by his use of humid analysis and was based on the evidence for consolidation and the derivative or fissile nature of the minerals in secondary strata. With primary strata, chemical analysis only provided enough information for discussing mineralogical composition. Although wet and dry analyses allowed some mineralogists to propose likely causes for consolidation,[66] Walker seems to think that there was not enough data to determine how Primary Earths were united into the indurated minerals that composed primary strata. This chemical conviction effectively eliminated temporal questions associated with the formation of the strata. This being the case, one of the only chemical tests mentioned in Walker's Hippocratean lectures that could even attempt to shed light empirically on the earth's age was the one that involved the 'saltness of the ocean'. But we have already seen how he felt this test actually hinted that the salinity level of the ocean was static. Such a position effectively rendered such a test useless when trying to determine the age of the earth. This is not to say he was uninterested in the role of time. He simply wanted to account for it in a manner that was empirically verifiable. Walker was not alone in this approach. In fact, the mineralogical community in Britain was interested in the chemical composition of strata well into the nineteenth century (Plates 6.III and 6.IV).

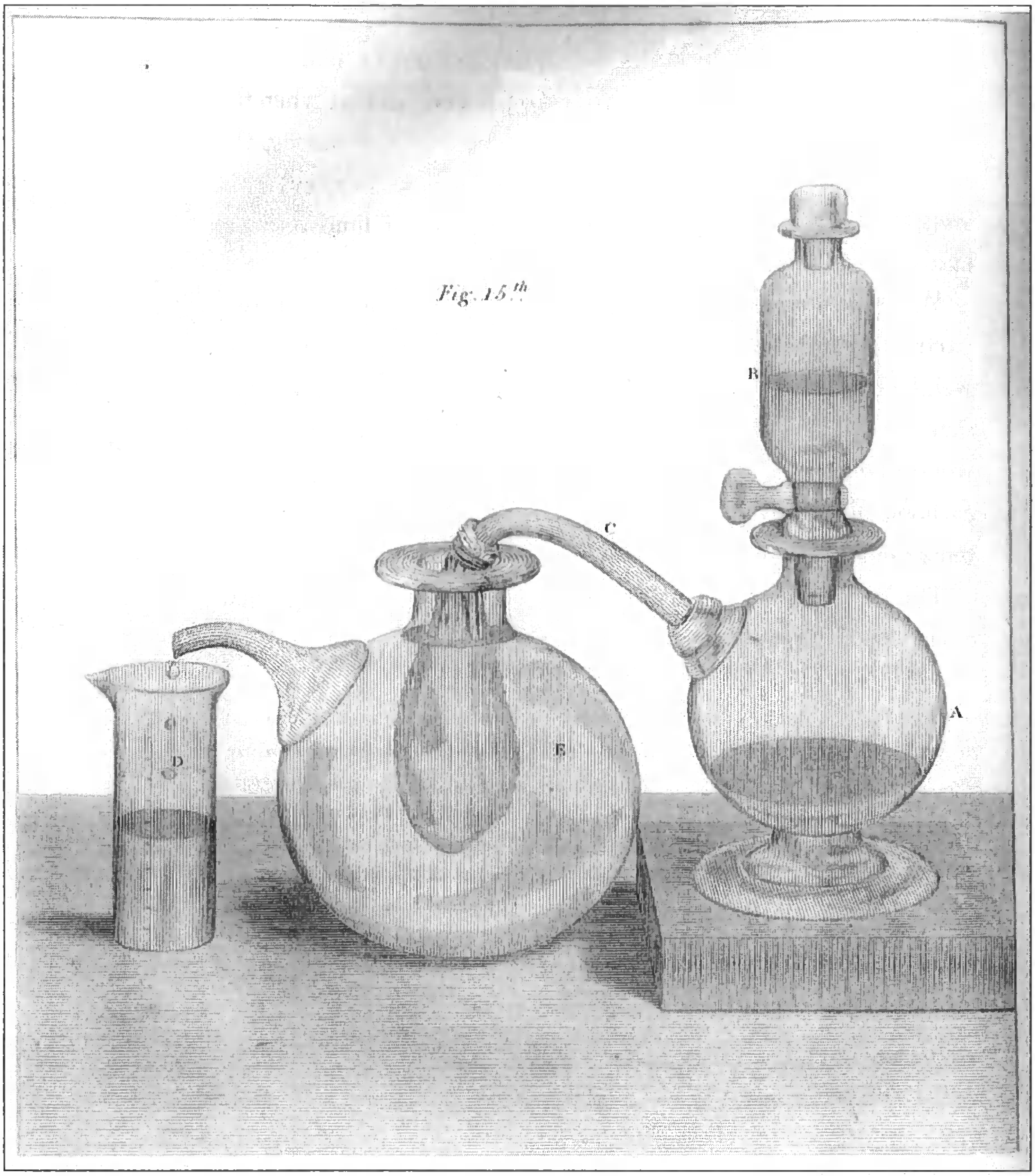
Character Naturalis and 'Monuments' of Chronology

As his mineralogy lectures indicate, Walker obtained a mineral's *character naturalis* by looking at its *situs*, *substantia*, *consistentia*, *figura*, *structura*, *partes*, *qualities* and *aer*. This not only worked well for mineralogy, but it also was helpful when discussing the 'monuments' of hydrography and geology. In this sense, Walker approached geological monuments with a Linnaean methodology. Using the above natural characters as a guide, he arranged his lectures into categories that resembled a binomial nomenclature. For instance, under the heading of 'Mountains' he lists 'seven species':

1. Conical	5. Table
2. Peaked	6. Faced
3. Rounded	7. Acuminated.
4. Ridgy	

his theory. In fact, he even includes a long quotation from Pierre Joseph Macquer's *Elements of the theory and practice of chymistry* (probably the London, 1764 edition) to support his position.

[66] Some of these theories were based upon experiments done upon human calculi. However, these only took a few years to form and therefore suggested that rocks could grow at the same rate over a relatively short period of time. See W. D. I. Rolfe, 'William and John Hunter: breaking the Great Chain of Being', in W.F. Bynum and R. Porter (eds.), *William Hunter and the eighteenth-century medical world* (Cambridge: 1985), 305-308. Cullen thought that calculi were made up of 'crystalline' substances (see Chapter 2). The impact of these human concretions upon the chemical conception of minerals and geology needs to be addressed in more detail. For more on how seventeenth century physicians thought calculi were composed of sand, see the sections on the removal of kidney stones in B. Nance, *Turquet de Mayerne as baroque physician* (Amsterdam: 2001).



Davy's Chemical Apparatus
Humphry Davy, *Elements of Agriculture* (London: 1813), Figure 13.

Using chemistry to determine the chemical composition of Earths had been practiced in Edinburgh's Medical School since it was founded at the beginning of the eighteenth century. During the 1780s and 1790s, Black used special apparatuses to isolate the 'airs' (usually CO_2) given off by calcareous Earths. By the 1810s, this had developed into a more finely tuned enterprise throughout Britain. By the time of Walker's death, the number of 'Earths' had increased well beyond five.

Plate 6.IV on the next page contains Davy's directions on how to use the above equipment.

* Fig. 15. A, B, C, D, represent the different parts of this apparatus. A. Represents the bottle for receiving the soil. B. The bottle containing the acid, furnished with a stop-cock. C. The tube connected with a flaccid bladder. D. The graduated measure. E. The bottle for containing the bladder. When this instrument is used, a given quantity of soil is introduced into A. B is filled with muriatic acid diluted with an equal quantity of water; and the stop-cock being closed, is connected with the upper orifice of A, which is ground to receive it. The tube D is introduced into the lower orifice of A, and the bladder connected with it placed in its flaccid state into E, which is filled with water. The graduated measure is placed under the tube of E. When the stop-cock of B is turned, the acid flows into A, and acts upon the soil; the elastic fluid generated passes through C into the bladder, and displaces a quantity of water in E equal to it in bulk, and this water flows through

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the tube into the graduated measure: and gives by its volume the indication of the proportion of carbonic acid disengaged from the soil; for every ounce measure of which two grains of carbonate of lime may be estimated.

Apparatus Instructions

Humphry Davy, *Elements of agriculture* (London: 1813).

He then states that 'every hill one the Globe may be reduced to on or other of these shapes'.[67] This sort of Linnaean arrangement of the geological 'facts' was followed by many of the authors that he mentions in his lectures. For example, regarding geological classification, de Luc states: 'If this method be duly considered, it will, I hope, be allowed, that, provided the *facts*, generalized under each head can be certified by the whole assemblage of descriptions which respectively concern them, all the *conclusions* then deduced are incontestable.'[68] In general, this approach harmonised well with the late eighteenth-century Baconian/Newtonian empiricism that was detailed in the first section of this chapter.

Walker believed the characters of such monuments provided several clues to the chronology of the earth's age. However, he did not believe such data provided enough evidence to propose a time scale that exceeded more than a few thousand years. Two good examples of this can be seen in his treatment of natural characters found in the ocean and in strata. The physical evidence seemed to indicate that the ocean and primitive strata were in a state of stasis. He addresses oceanic stasis in his hydrography lectures, particularly in the section on the ocean's 'access' and 'regress'. He begins by disagreeing with Aristotle and Linnaeus, who both held that the ocean was in a gradual state of recession. He states: 'It appears not however that as far as history or tradition goes that either the access or recess of the ocean have been considerable.'[69] The word 'considerable' is important to note because Walker cites examples from Tuscany, Venice, Britain and Holland where the sea has risen and examples from Bernice and Ravenna where it has fallen. It appears that he sees these as minor oscillations in relation to the size of the ocean.

Walker's geological lectures demonstrate that he also felt the composition of primitive mountains was static[70] and distinctly different from secondary mountains. 'Notwithstanding the degree of evidence which we have, you will find several writers and even some very late writers who endeavour entirely to abolish the distinction between primitive and secondary mountains. But it is one which I am confident is founded in nature, and therefore must continue to stand its ground.'[71] Furthermore, as we saw above, his treatment of strata is subjugated to chemically grounded epistemology of his mineralogical system: 'I come now to a distinction in

[67] Walker (1966), 'Geology Lectures', 170-171.
[68] De Luc (1810), 4.
[69] Walker (1966), 'Hydrography Lectures', 126.
[70] There were many natural historians at this time who held a similar position. De Luc, Philip Howard, John Gough and William Richardson (just to name a few) all denied the possibility of extensive denudation. For more on the 'Denudation Dilemma' at this time, see Davies (1968), 113-128.
[71] Walker (1966), 'Geology Lectures', 176.

Mountains, to which I beg your particular attention, because of its great moment in the *Science of Mineralogy*, and in the natural history of the earth; it is that distinction by which mountains are divided into primitive and secondary.'[72] He specifically believed there was only enough physical evidence to assert that primary mountains were formed by a 'uniform Cause' that at some point involved a large chemical solution. Likewise, he did not hold that they were a product of sporadic matter, that is 'All those fossils [e.g. rocks or minerals]... which are included or embedded in any stratum.'[73] His treatment of primary mountains does not broach the topic of cosmogony, gives no time scale for their formation, does not define 'uniform Cause', does not refer to events that took place before their formation, asserts they were formed at the same time as the globe (i.e. the whole earth) and that they have been in a relative state of stasis ever since. 'It would appear in general that the mountains of the globe are coæval with it, and it is fanciful to suppose that this globe ever wanted them, or that they have been formed in the course of succeeding ages.'[74] As we have seen earlier, his method was firmly supported by a teleological mindset and would have *implicitly* seen God initiating such a uniform cause.[75]

Curiously enough, Walker also believed that the actual physical composition of primitive mountains had not changed since their formation. He admits that it is reasonable to think that, at first glance, it might appear that primitive mountains have been gradually worn down. But upon closer examination of the facts, he sees this perception as erroneous. He argues that mountains do not perceptibly lose their height because their summits are 'hard rocks covered with crustaceous Lichens.' Such tough combinations are able to repel the possible erosive effects of wind and rain. Moreover, the terrestrial matter that one sees deposited at the bottom of a mountain is not a product of the mountain's primary rock. It is actually superadded to the original mass, being carried there either originally by rains or being the remnant of decayed plants.[76] His views on river channels demonstrate a similar view

[72] *Ibid.*, 'Geology Lectures', 173. The italics are my own.
[73] *Ibid.*, 'Geology Lectures', 175.
[74] *Ibid.*, 'Geology Lectures', 176. Also see W. Smellie's similar definition in the 'STRATA' entry in the *Encyclopædia britannica, Vol. III* (1771), 636. Part of it states: 'The time when these several strata were laid, was doubtless at the beginning of the world; unless, with some great naturalists, as Steno, Dr. Woodward, &c. we suppose the globe of the earth to have been dissolved by the deluge.'
[75] Walker hints at this in the end of his Hydrography lectures, 'Every part [of the globe] is thus supply'd with water, and if there are any little inequalities they serve only to shew the great wisdom [with which] the whole is conducted. There we may behold the footsteps of that divine power which every where pervades the works of nature.' (Walker: 1966), 'Hydrography Lectures', 164. Compare to Smellie's translation of Buffon's 'On Nature' chapter in *Natural history*: 'Omnipotent God! whose presence supports Nature, and maintains harmony among the laws of the universe.' His entire chapter is replete with such references.
[76] Walker (1966), 'Geology Lectures', 173-174. Buffon maintained a similar opinion in Article VII, 'Of the Formation of Strata, or Beds, in the Earth' in his *Natural history*, 'The vapours exhaled from the earth produce rain, dews, thunder, lightning, and other meteors. The vapours, therefore, are mixed with particles of water, air, sulphur, earth &c...The purest rain-water deposits a quantity of this mud; and, when a quantity of dew is collected, and allowed to corrupt, it produces a greater proportional quantity of mud, which is fat, unctuous, and of a reddish colour.' Buffon (1780), 44.

of stasis. He propounds that, over the course of time, rivers *do not* cut down into strata: 'It appears then upon the whole that the channels of the Rivers have not been fortuitously formed, and especially in all rocky countries, they have most probably been at least coeval with the rivers themselves.'[77] He cites the remarkable meanderings of Highland rivulets and the River Avon in Bristol to illustrate this point. The former example was no doubt taken from his own travels and the latter was also employed by de Luc.[78]

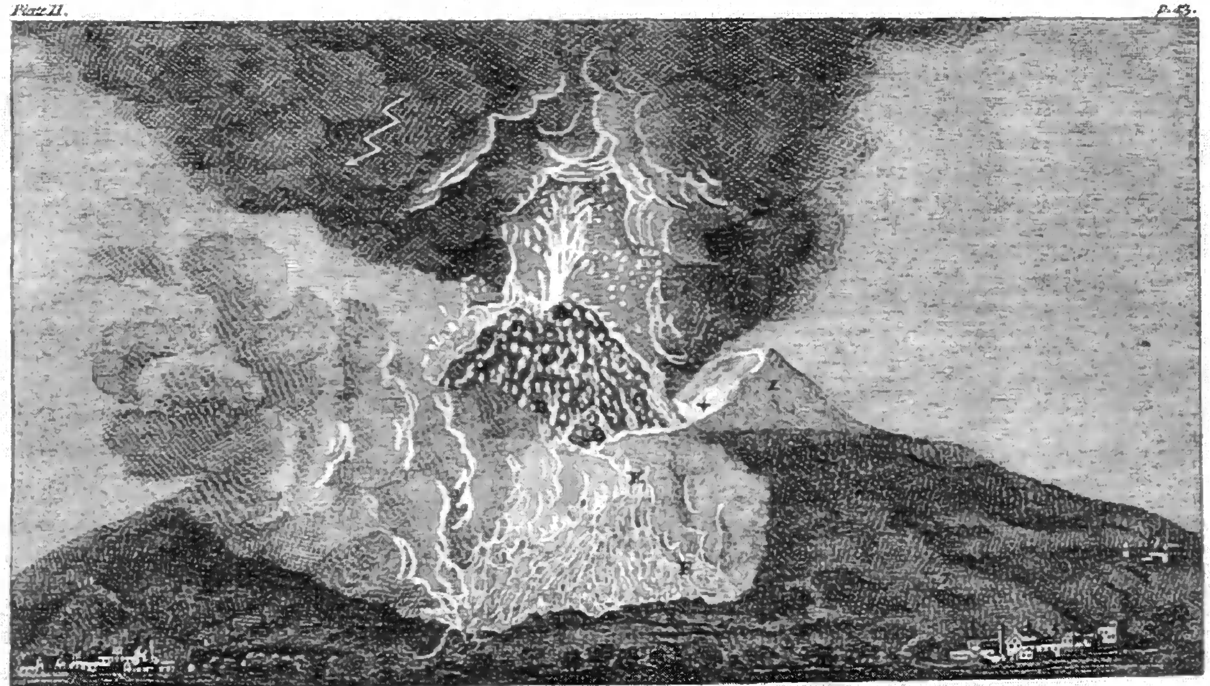
Building on the two different aqueous upheavals mentioned in the previous section, Walker holds that primary and secondary strata were formed at different times. He states that, 'Mountains of this globe have been formed by one general and uniform Cause, and that the primitive and secondary mountains have been formed at two very different æras.'[79] He emphasises that 'extraneous fossils', i.e. organic remains in the ground, exist in secondary strata, but not in primary strata.[80] This demonstrated that secondary strata were coeval with the existence of life and were therefore younger than primitive strata. In his geological lectures, Walker's comments about secondary strata are a bit more general when compared to the amount of information devoted to explaining primitive and tertiary strata.[81] This was most likely because they fell between the conceptual importance necessitated by primitive strata and the relative availability of data afforded by tertiary strata. Thus, when determining the age of secondary strata, Walker's system placed them within the temporal brackets provided by these strata. Within such a system, he uses 'extraneous fossils' as a device to fine-tune a chronological age of the earth that is no more than several thousand years.[82] This practice was similar to many natural philosophers of the time, Bergman being one of them. Concerning 'petrefactions', he states that 'We may, and ought, to consider them as medals deposited by the hand of nature, in memory of the more remarkable changes on the surface of the earth, and from which the time and order of the work, may, in some measure, be judged of,

[77] Walker (1766), 'Geological Lectures', 156. Richard Kirwan used a similar argument against Hutton's theory. Richard Kirwan, *Geological Essays* (London: 1799).
[78] De Luc (1810), 22-227.
[79] Walker (1966), 'Geology Lectures', 175. Walker uses the word 'æra' to connote large spans of human time like the Roman era or the modern era. For instance, 'A body which was there dug out of the peat moss had on its feet antique sandals, which plainly shew'd it to be of the Roman æra', p. 199.
[80] 'There is another remarkable and well established distinction between primitive and secondary mountains, which is that the primitive contain no extraneous fossils.' Walker (1966), 'Geology Lectures', 175.
[81] This was no doubt because of time constraints. In his mineralogy lectures, Walker gives a significant amount of attention to the specific minerals that compose secondary strata.
[82] [Anon.] (transcriber), *Lectures on natural history, Vol. IV* (1790s) EUL DC.2.19. This time scale was quite common at the time. For instance, William Smith, famous for his *Geological map* (1815), did not attach any significant age to strata early in his career. It was only after he moved to London and encountered the geo-theological ideas of John Farey (c. 1806) that he began to change his position. H. S. Torrens, 'Timeless order: William Smith (1769-1839) and the search for raw materials 1800-1820', in C. L. E. Lewis and S. J. Knell (eds.), *The age of the earth: from 4004 BC to AD 2002* (London: 2001), 61-83.

whilst other monuments are silent.'[83] Walker could use extraneous fossils in this manner because he did not believe in complete extinction (although, based on peat bog excavations and Roman records, he does entertain the idea of local extinction).[84] Because of the many unexplored areas of the earth, Walker held that all extraneous fossils had a living corollary, either already known or waiting to be discovered in the uncharted wilds of other continents or in the vast depths of the sea.

A final note must be paid to Walker's comments on volcanic strata.[85] Some of the most common sources about volcanoes were the books and *Philosophical Transactions* articles of Sir William Hamilton.[86] In his geology lectures, Walker specifically mentions Hamilton's 1771 and 1779 observations of Vesuvius (Plate 6.V). In addition, he gives his own observation of the 1783 phenomena associated with the Hecla eruption in Iceland and cites classical and modern works on the subject.[87] Based on such information and the nuances of his own methodology, he held that volcanoes were a type of tertiary strata.[88] He held this because volcanic eruptions were clearly an event that still could be witnessed today and therefore fell within the more recent formation allotted to *tertiary* strata. Such a position was, once again, based directly on physical 'monuments' that could be seen above ground and not upon theories (either about volcanoes or earthquakes) which hypothesised untestable causes of events taking place below ground.[89] On a deeper level, he held that such physical classifications should be based on mineralogical evidence anyway. Accordingly, his mineralogy lectures demonstrate that he believed basalts were not igneous[90] and were a form of primary strata.[91] Though there were many other

[83] He goes on to say that they can be used to interpret the 'unbounded empire of the sea', which clearly demonstrates that he thought fossileous strata were formed by the flood. Bergman (1783), §265.
[84] See his comments on the former presence of the elk in Scotland and the Scotch pine in England. Walker (1966), 'Geology Lectures', 196-198.
[85] Because of the connection often made between earthquakes and volcanoes, a significant amount of attention was given to this subject after the Lisbon earthquake in 1755. It served as a commonplace for most natural historians when discussing subterranean issues. For the immediate reaction to the Lisbon earthquake, see the many letters printed in the 1755 editions of the Royal Society's *Philosophical Transactions*. Walker also owned the following books that addressed this topic: J. Bevis, *The history and philosophy of earthquakes from the remotest to the present time*... (London: 1757) EC 213; P. Lozano, *A true and particular relation of the dreadful earthquake which happen'd at Lima... 1746*, Henry Johnson (trans), (London: 1748) EC 291. In addition to these sources, Walker owned B. F. de Saint-Fond's *Minéralogie des volcans: ou, description de toutes les substances produites ou rejetées par les feux souterrains* (Paris: 1784) EC 310.
[86] W. Hamilton, *Observations on Mount Vesuvius, Mount Etna and other volcanoes, in a series of lectures addressed to the Royal Society of London*... (London: 1772). Hamilton was the British envoy, in Naples, to the court of King Ferdinand IV from 1764 to 1800. Walker owned the French version: W. Hamilton, *Observations sur les volcans des Deux Siciles telles qu'elles ont été communiquées à la Societé Royale de Londres par le Chevalier Hamilton*, Campi Phlegræi (trans), (Paris: 1781) EC 293. Walker also owned a copy of Francesco Sereo's *The natural history of Mount Vesuvius*... (London: 1743) EC 226.
[87] The series of volcanic eruptions that occurred in Iceland during 1783 and 1784 (and the reaction to them by the Icelanders, British and Dutch) is addressed in K. Oslund, 'Imagining Iceland: narratives of nature and history in the North Atlantic', *BJHS*, **35** (2002), 313-334.
[88] Walker (1966), 'Geology Lectures', 176.
[89] For instance, see J. Mitchell, 'Conjectures concerning the cause, and observations upon the phænomena of earthquakes', *PT*, **51** (1760), 566-634.
[90] 'The Basaltes have been accounted a Volcanic Production, but of this we have not any satisfactory proof whatsoever.' Pollock (transcriber), *Epitome of natural history Vol. VI* (1797), EUL Gen. 708D f. 93. In this belief he was supported by many authoritative mineralogists, including Bergman. See Schuffle (1967), 77. Walker held that the 'most possible opinion' was that basalts were indurated shistic earth that were divided into columns by mechanical means. [Anon.] (transcriber), *Lectures on natural history 1790 Vol. IV*, EUL DC.2.26 f. 58.



View of the GREAT ERUPTION of VESUVIUS 1767. from Torre dell'Annunziata.

Mt. Vesuvius (1767)
William Hamilton, *Observations on Mount Vesuvius*, (London: 1772), Plate II.

Hamilton's book on Vesuvius had done much to call attention to the eruptions of the ancient volcano. It erupted several times during the eighteenth century and there were varied hypotheses put forth to explain the phenomena. Many of these were chemical and do not fit into the 'Neptunist' and 'Vulcanist' categories so often thrust upon the late Enlightenment. In Walker's case, he held that lava was a form of tertiary strata (as explained in Chapter 6).

opinions of basalts that were based on *prima facie* physical interpretations,[92] his were based on evidence supplied by chemistry and mineralogy and implicitly upon the concept of chronological time that he associated with such approaches.

Written and Archaeological 'Monuments' from Human History

As Rappaport has shown, civil and religious histories played a prominent role in seventeenth- and eighteenth-century geological discourse: 'Quite early in the century, professional historians had tackled the question of credibility of ancient legends and oral traditions. They had concluded that tradition could transmit accurately—in outline, if not in detail—any event that was large, dramatic, and public.'[93] She goes on to say that, 'Such critical precepts applied in all their force to the flood.' Consequently, the discussion of the flood (and other upheavals) blended into what Hookyaas has called a 'Mosaic philosophy'.[94] A classic example of how biblical exegesis was used in this area can be seen in the debates over the formation of the earth's crust that took place between two of Walker's sources: Keill and Burnet. Early in the debate, Keill had intentionally tried to steer clear of the Mosaic account whilst poking holes in Burnet's natural philosophy. However, when Burnet suggested that Keill's exegetical skills were lacking, Keill issued a response that contained a plethora of references to Hebrew, Greek, Latin and Syriac sources.[95] These types of debate often hinged on whether or not one accepted the account given in Genesis and it was for this reason that Patrick Cockburn, a prominent author later in the century, stated the following in his *An enquiry into the truth and certainty of the Mosaic deluge*: 'In this Enquiry, therefore, we shall consider the character of *Moses* only as a historian. Not to pay the same regard to *Moses* as we do the *Greek* or *Roman* historians would be contrary to both reason and justice.'[96]

The end result of such debates was that classical and biblical sources were frequently used to supplement empirical observations. As Keill aptly put it: 'There are two sorts of Arguments that may be brought against the Theory, the one depends

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[91] Specifically, its *situs* is listed as *stratis primitivis* in his 1797 lectures. Pollock, (transcriber), *An epitome of natural history Vol. VI* (1797), Gen. EUL 708D, f. 87.

[92] J. Strange, 'An account of a curious Giant's Causeway, or group of angular columns, newly discovered in the Euganean Hills, near Padua, in Italy', *PT*, **65** (1775), 418-423. J. Strange, 'An account of two Giant's Causeways, or groups of concretions, in the Venetian state in Italy', *PT*, **65** (1775), 5-47. R. E. Raspe, 'A letter from Mr. R. E. Raspe, F.R.S. to Mr. Maty, M. D. Sec. R. S. containing a short account of some basalt hills in Hassia' *PT*, **61** (1771), 580-583.

[93] Rappaport (1978), 15. Rappaport examines this context in more depth in her more recent work entitled: *When geologists were historians 1664-1750* (London: 1997).

[94] R. Hookyaas, *Religion and the rise of modern science* (Edinburgh: 1972), 115-116.

[95] Keill, (1734), 179-197. Keill goes on to criticize Whiston's exegetical account of the earth's formation on pages 306-310. Also see Whitehurst's use of Greek, 'Phonecian', Egyptian and Greek, (1778), 9-13, and Whiston's extensive treatment of the 'mosaick' creation, (1796) pages 1-94.

[96] P. Cockburn, *An enquiry into the truth and certainty of the Mosaic deluge...* (London: 1750) EC 404, 3. Walker's library also contained: T. Robinson. *New observations on the natural history of this world of matter...* (London: 1696) EC 224.

only on the principles of Reason and Philosophy, and the other on the Authority of the writings of Moses.'[97] Walker fits firmly into this context and his lectures, letters and personal notes confirm that he was a keen antiquarian. As was mentioned in Chapter 4, Walker's mineralogy lectures demonstrate that he was particularly well versed in the works of Pliny. It should therefore not be surprising to learn that he continues to cite him and several other classical historians (such as Dio Cassius) in his geology lectures.[98] Not only was he well versed in the classical Roman, Greek and Jewish texts (it must not be forgotten that his first degree was in theology), he also spent a good deal of time studying the ancient language, customs and mythology of the Scottish people.[99] His field notes and correspondence (especially to Lady Kames) demonstrate that he applied his knowledge in this area to the geological formations that he encountered while on his expeditions to the Hebrides and Highlands.[100] Relatedly, his interest in both Scottish and classical Antiquity allowed him to cite entertaining examples from human history throughout all of his natural history lectures. Since he held that human existence was coeval with secondary and tertiary strata, he was able to use artefacts associated with the 'population and progress of Mankind' as a marker of chronological time within the strata. This situation particularly allowed him to use both the physical monuments found in classical works alongside extraneous fossils as potentially viable empirical evidence.

Additionally, particularly in his mineralogy lectures, Walker often draws from archaeological accounts that detail the composition of ancient constructions like statues, obelisks and buildings. He uses these examples to demonstrate the durability or degeneration of select stones and minerals. For the most part, they illustrate his conception of primitive and secondary strata that was discussed above. For instance, he uses the basalt statue of Somnus in Rome to demonstrate that basalts are the 'most durable of all stones and most undoubtedly are the best adapted for works of Arts intended for duration.'[101] In general, the mingled presence of human artefacts and animal remains in secondary strata convinced Walker that they were coeval with human existence. For instance, he states at one point that salt deposits are probably secondary strata based on a report of a man who found a ship's keel buried at 50

[97] Keill (1734), 134.
[98] Walker (1966), 'Geology Lectures', 189; 204.
[99] Notably, he opposed the view that Gaelic was not a written Language. 22 March 1775. Donald McNicol [of Lismore] to Walker. EUL La.III.352/1 ff. 40-43. He also was interested in the language of Ireland: EUL DC.1.59, f. 63.
[100] For instance, in a letter to Lady Kames regarding his 1771 Hebrides expedition, dated 29 February 1772, Walker takes care to highlight several of the mythological sites he visited, some of the more notable being: Fingal's residence (he gives the etymology of the Gaelic name Selma), the Sunny Spot of Darthule and Hill of the Fingalians in Glencoe. He even goes on to reference MacPherson's *Ossian* poem. NAS GD 24/1/496-503A/629-630.
[101] [Anon.] (transcriber), *Lectures on natural history vol. III* EUL DC.2.19 f. 263 and [Anon.] (transcriber), *Lectures on natural history Vol. IV* (1790) EUL DC.2.26, f. 56.

fathoms (300 feet) in a Polish salt mine.[102] He also notes that excavated fossil shells sometimes contain crystals—which implicitly made it possible for them to be the same age as the oldest secondary strata.[103]

Even though Walker did have a great amount of experience with observing primary and secondary strata, his geology lectures and published writings demonstrate that tertiary strata were more appealing to him. Tertiary strata were formed from substances like river silt, shell marl, peat bogs, lava and mountain erosion.[104] As in his discussion of primary and secondary strata, he often details the composition of tertiary strata without introducing the element of time. An example of this is when Walker discusses coral islands. He first states that coral grows up from the bottom of the ocean and then collects soil which creates an environment where plants and animals can live. He then mentions that Pacific coral islands often grow up around deposits of primary rock, thus hinting that the coral base is not a cause in itself. Accordingly, he does not give any indication of how long this process might take.[105] But there are several instances were he dates tertiary strata based on human artefacts. It is in these sections of his lecture notes where we find the clearest examples of how he used human artefacts and written histories to date strata. He refers to human history because reports on the properties of so many natural objects and phenomena were often sparse to non-existent during his time, and because of the epistemological priority his methodology gave to personal observation. Looking at examples of how he used human history to date tertiary strata gives the clearest picture of his conception of time's involvement in geological and hydrological change. I shall examine his dating of two types of tertiary strata: sedimentation and peat.

In his section on islands in his geology lectures, Walker avers that a sedimental isthmus can form and then connect an island to the mainland, thus making a peninsula. He then gives an example set against the backdrop of human history to illustrate the time element involved in such a process. He states that the island in the Nile Delta that once contained the ancient lighthouse of Alexandria had become a peninsula by modern times.[106] His calculation of the overall sediment deposit of the Nile since the Greeks is more enlightening. Based on figures given by

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[102] Walker (1966), 'Geology Lectures', 182.
[103] [Anon.] (transcriber), *Lectures on natural history vol. III* EUL DC.2.20, ff. 4-6.
[104] For his discussion of peat moss, see: Walker (1966), 'Geology Lectures', 189-199.
[105] *Ibid.*, 'Geology Lectures', 179-180.
[106] *Ibid.*, 'Geology Lectures', 177-179. These types of mathematical calculations commonly used in the seventeenth and eighteenth centuries. Halley was quite keen on calculating the volumes of lakes and rivers based on precipitation and rainfall. His observations in this area were cited and discussed well into the late eighteenth century. For instance see Matthew Dobson's, 'Observations on the annual evaporation at Liverpool in Lancashire...', *PT*, 67 (1777), 244-259.

Herodotus, he states: 'the Delta has in the course of 3284 years increased 14 cubits in height, and indeed if we are inclined to allow its formation from the sediment of the Nile, this is a very moderate degree of quickness.'[107] Considering that the English cubit was 18 inches, this would mean that the Delta had grown by 252 inches (21 feet), which is roughly 1/13 inch every year. Herodotus was one of the earliest sources of natural history for Walker and this measurement demonstrates that Walker's conception of tertiary change over three thousand years was *minimal*. This sentiment is demonstrated elsewhere, particularly in Walker's discussion of peat moss.[108]

Walker was a known authority on peat moss[109] and I have already noted how he used peat bogs in conjunction with Roman records to discuss local extinction. In his geology lectures, he states that various artefacts from the past have been found buried in peat moss: A Roman camp kettle at six feet in Flanders moss; Saxon coins and a silver crucifix at six feet in Lochart Moss; Roman gold at three feet in Annandale.[110] Taking note of the depth of these artefacts is very important because he holds that nearly all peat mosses are coeval. He asserts: 'There is likewise a surprising similarity in the depth and extent of peat mosses in different parts of the world where they exist, which shews that they have been all nearly coæval. In general peat mosses are found from 5 up to 20 feet in depth all over the world over.' He goes on to state that, 'In Scotland our deepest mosses are generally about 12 feet. I have indeed seen them 18 feet deep but this more rarely happens.'[111] He gives the average figure of twelve feet because he is aware that local conditions may accelerate or retard the growth process. These numbers demonstrate that it had taken around 1700 years for six feet of moss to cover a Roman artefact. Thus, if the average depth of peat moss in Scotland was twelve feet, the average age of Scottish peat moss was

[107] Walker (1966), 'Hydrography Lectures', 157-160.
[108] Walker's discussion of other tertiary strata such as Stapple and Sea Sand also demonstrate a similar atemporal conception of time. Walker (1996), 'Geology Lectures', 189-190 and 192-193.
[109] J. Walker, 'An Account of the Irruption of Solway Moss', *PT*, **62** (1772), 123-127; 'An Essay on Peat, Containing an Account of Its Origin, of its Chymical Principles and General Properties,' *Prize essays and transactions of the Highland Society of Scotland*, **2** (1803), 1-137.
[110] The relation between early modern archaeology and 'geology' is treated in M. R. Goodrum, 'The meaning of ceraunia: archaeology, natural history and the interpretation of prehistoric stone artefacts in the eighteenth-century', *BJHS*, **35** (2002), 255-269.
[111] Walker (1966), 'Geology Lectures', 197.

about 3400 years old,[112] a figure which did not exceed chronologies provided by classical histories or by scripture.[113]

Conclusion

John Walker's conception of geology was based upon a definition and division methodology that he inherited from chemistry and mineralogy. This methodology was built upon an epistemology which was shaped by the strict version of empiricism that dominated the 'local realities' of the Scottish Enlightenment. Even though the majority of his geology sources were not Scottish, the background assumptions about chemistry, mineralogy and method were. These influenced his perception of natural philosophy and guided his selection of the 'facts'. His reading of natural history texts was therefore highly critical of hypothetical theories and he saw no viability in unverifiable systems that necessitated long periods of time. Building upon this methodology and epistemology, he used chemical, physical and historical forms of investigation to analyse the data provided by natural 'monuments'. Based on the *a priori* status of Primary Earths and the lack of evidence regarding the cause of induration, chemical analysis fell short of the empirical standard needed to determine the age of primary strata conclusively.

Moreover, since Walker's physical and historical analyses of the minerals in these strata demonstrated that their composition was static, he was forced to look at secondary and tertiary strata to help him determine the age of the earth. The data supplied in these strata only allowed him to address events that were no more than a few thousand years old. Yet, no matter how long the chronology of secondary or tertiary strata proved to be in the future, he believed that the very physical placement of primary strata made it the chronological starting point. This assumption effectively gave *a priori* status to primary strata within a system that espoused an *a posteriori* methodology. Thus, primary strata, though undateable, always formed the first bracket of any proposed geological time scale. As further evidence was

[112] Walker also discusses peat in a shell marle essay. It seems he believed that marle formed on top of peat was made from shells, but marle formed underneath was not. Thus, the time element involved in making shell marle falls within the perimeters of peat moss development outlined in his lectures. See 'The History of Shell Marle' (ca. 1770), in *Essays on natural history and rural economy*, Charles Steward (ed), (Edinburgh: 1808; London: 1812). For unknown reasons, Scott includes *parts* of this essay in his 1966 edition of Walker's lectures even though it was published posthumously and even though it was as an essay, not a lecture. Walker briefly addresses shell marl in his posthumous *An Economic history of the Hebrides and Highlands of Scotland*, (London: 1812), 141-142.

[113] There were many biblically based ages of the world floating around eighteenth century Britain. Generally, calculations based upon the *Vulgate* provided a 6000 year age, while calculations based on the *Septuagint* provided a 7000 year age. The 6000 year time frame, as promoted by Ussher, became much more popular in the nineteenth century after it had been included in the seventeenth edition of the King James Version of the Bible. J. Fuller, 'Before the Hills in Order Stood: The Beginning of

discovered, the bracket, like a bookend, could slide either forward or backwards, but always remained at the end.

Because of the emphasis often placed upon the development of stratigraphy and the division made between mineralogy and geology during the first two decades of the nineteenth century, mineralogically influenced geologists like Walker are often forgotten (as are the later nineteenth-century 'chemico-geologists').[114] Indeed, they could even be called victims of historians interested in tracing the progenitors of geology as it is known today. This chapter has shown that instead of using modern geological assumptions to judge the works of the eighteenth century, it would be more beneficial (for Scotland at least), to start first with principle-based chemistry, to continue on to mineralogy and then to finally end with the nascent field of 'geology'. This 'bottom up' approach would shed more light upon the first 'geologists' who used chemistry and mineralogy to create a new field of enquiry. Additionally, it would clarify how the Scots used 'primeval fluids' to explain the genesis of primary strata that was not the product of the Noachian flood. Finally, concentrating on the epistemology and methodology of chemical-mineralogy would make it easier to judge the larger impact of medicine upon Scottish conceptions of the earth's form and structure during the 1780s and 1790s.

the Geology of Time in England', a paper given in London on 29 June 2000 for a conference entitled 'Celebrating the Age of the Earth' (hosted by the Geological Society of London).

[114] W. H. Brock, 'Chemical geology or geological chemistry?', in L. Jordanova and R. Porter, *Images of the Earth* (Chalfont St. Giles: 1979), 147-170.

Conclusion

It has been the purpose of this thesis to excavate John Walker's chemical, mineralogical and geological conception of the earth's composition and structure. This was done by comparing his work to ideas that were in circulation in his national context and local reality. Such an approach was most influenced by Knight's writings on scientific biography, Porter and Teich's 'national context' and Nicholas Jardine's 'local reality'. In addition to these factors, I also used Walker's library to help intellectually locate his pursuit of natural history. The primary sources for this study were Walker's own work (both manuscript and printed) and student notes taken over a twenty year period in his hydrography, mineralogy and geology lectures. At points these sources were supplemented by letters written by and to Walker throughout his entire career. Based on these works and documents, the preceding chapters argued that his conception of geology was based upon mineralogy, which was in turn based upon the methods and nomenclature of principle-based chemistry.

To set the stage, Chapter 1 gave a biographical introduction to Walker's career and context. Educated to be a minister in the Established Church of Scotland, he began to dabble in natural history and natural philosophy while he was a student at the University of Edinburgh. After he was ordained, he maintained his contacts with Edinburgh's scientific community and forged links with the influential aristocrats and Judge Advocates who lived in the Lowlands. Such social connections enabled him to create a vast correspondence network that not only spanned Britain, but also reached into Europe, India, the Caribbean and North America. In 1779 he skilfully used his scientific and aristocratic connections to be appointed as the University of Edinburgh's second Regius Chair of Natural History, a professorship that was attached to the Medical School. In this capacity he taught at least seven hundred students over the course of the next two decades. His lectures were popular and attracted students not only from all levels of Scottish society, but also from Europe and many of Britain's colonies. Many of these students went on to have significant impact on science, politics and literature during the end of the eighteenth century and on into the first four decades of the nineteenth.

Chapter 2 outlined Walker's early education and career in chemistry. It began by detailing the courses that he took at the University during the late 1740s and then went on to show that he studied chemistry with William Cullen during the mid 1750s. Cullen taught Walker to approach chemical experimentation via the methods and epistemology associated with five 'principles': Water, Earth, Salt, Metal and Fire. This principle-based approach had its roots in the Becher-Stahl School of chemistry and had been modified to fit within Edinburgh's staunch commitment to empiricism. At the time, chemistry in Edinburgh was dominated by saline based experimentation and this led Walker to publish his own article on the topic in the 1757 edition of the *Philosophical Transactions*. Entitled, 'An Account of a new medicinal Well, lately discovered near *Moffat*, in *Annandale*, in the County of *Dumfries*', it examined the composition of the Hartfell Spa, a chalybeate spring. In this article Walker explored the saline and terrene composition of the well and concluded that it contained both an acidic and an alkaline 'principle'. Based on this article and upon the books listed in his 1761 *Index Librorum*, it was shown that his knowledge of chemistry was quite sound and that his experiments tied into the Medical School's larger interest in saline nomenclature and in experimental pharmacology.

Saline analysis in Edinburgh depended upon a wide variety of agents derived from minerals. This allowed Walker's chemical education to also serve as an introduction to mineralogy. Since his conception of 'stones' would later go on to influence his geology, Chapter 3 outlined Walker's early career as a mineralogist. The main sources for this section were Walker's personal notebooks from the 1760s and 70s (especially one entitled *Adversaria*) and his *Index Librorum*. The first part of the chapter concentrated on his chemistry teacher, William Cullen, and demonstrated that he used the Earths of principle-based chemistry to form nomenclatural categories under which he could arrange stones. Walker's first mineralogical arrangement used the same approach as Cullen and was based upon four Earths (vitrescible, calcareous, talcy and argillaceous) and included additional categories for Salts, Metals and Inflammables. Even though he read mineralogical works that used natural characters (Linnaeus and Da Costa for example), his chemical training made him partial to the works of chemists like Wallerius and Cronstedt. However, in order to classify minerals, Walker needed to acquire his own specimens. He did this via travel, patronage and correspondence networks. By travelling the greater part of Scotland, Walker was able to collect stones and to establish himself as a mineralogical authority. This earned him respect in the

Medical School and placed him in contact with aristocrats and Judge Advocates, who then introduced him to their own natural history correspondents.

Walker was appointed Professor of Natural History in 1779 and he began to lecture in 1782. In addition to treating various other aspects of natural history, he took particular pleasure in mineralogy. As a professor, he was able to turn the research that he had conducted over the past thirty years into a classification system that he could teach to his students. In doing this, he consulted a plethora of authors and used a wide variety of descriptive language. Chapter 4 investigated the latter aspect of his mineralogy by identifying the books and vocabulary that he used to create his system. This analysis was based upon several sets of lecture notes taken by Walker's students and the *Catalogue* made of his library after he died in 1803. It showed that his mineralogical canon was dominated by works of chemical mineralogy. Although he consulted classification systems that were based upon natural characters, the authors that most influenced his thought were those which had been recommended to him by Cullen and a wide variety of newer ones like Bergman who were based upon the chemical (artificial) characters of principle-based chemistry. His preference for these sources had a profound effect over the vocabulary that he used to describe minerals. This meant that, although he did follow Linnaeus' practice of applying botanical terms to minerals, the greater part of his vocabulary came directly from chemistry.

When Walker began to lecture in 1782, he presented his students with a significantly enlarged version of the classification system that he had developed during the 1760s. Drawing on the syllabi that he had printed throughout his career, Chapter 5 demonstrated that his later nomenclatural categories were also derived from principle-based chemistry. As in the past, he used the 'Primary' characters associated with the principles of Earth, Salt, Metal and Fire to form each of his classes. To arrange the lower nomenclatural categories (order, genus, species and variety), he often used characters generated by the 'Secondary' combinations of these four principles. Based on this nomenclature, all of his systems consisted of two major divisions: Stones and Minerals. Using David Pollock's 1797 lecture notes, Chapter 5 showed Walker held that *Stones* were composed of Bergman's five earths: calcareous, argillaceous, magnesia, terra ponderosa and siliceous (which was a slight modification of the Earths that he used in the 1760s). There were two different types of stones—each being governed by a different methodology. The first were Small Stones. These were arranged via an artificial method based strictly on their chemical composition. The second were Large Stones. Although their class was determined by a natural method that used physical size, Walker used chemical characters to arrange their lower nomenclatural categories. In terms of his geological thought, the most important of these stones were those in the Saxa Class—which included granite and other rocks that made up the 'Mass of the Matter of the Globe'. In addition to stones, the last part of his system consisted of *Minerals*. To arrange these, he reverted back to an artificial methodology based on characters derived from the principles of Metal, Salt and Fire. He devoted one class to each of the latter two principles. Metals were divided into three classes.

In using chemistry to classify minerals, Walker was building on the highly empirical methodology espoused by most of Edinburgh's enlightened literati. Chapter 6 explored how this intellectual context laid the epistemological foundation for his conception of the new field of 'geology'. His personal manuscripts demonstrate that he held that there was an omnipotent God who sustained nature via laws discovered by the observation of empirical data. Frowning upon conjecture, this led him to dismiss the theoretical speculations of cosmologists like Descartes and Buffon. As a result, he firmly held that all dialogue about the composition of the globe must be based upon the empirically observable 'facts' provided largely by one 'art': chemistry. Looking at the earth via this perspective built upon his vast knowledge of chemical mineralogy and allowed him to continue using a highly respected methodology that operated within a non-historical epistemology. Like most mineralogists of his day, he divided the earth's larger composition into three basic types of strata: primary, secondary and tertiary. Echoing his conception of Saxa Stones, such an 'arrangement' was based upon the natural character of 'size'. Furthermore, similar to the orders of Saxa Stones, the actual formation and composition of strata was based on chemical characters. This made their structure and existence implicitly dependant upon the chemical processes (concretion, congelation, crystallization and petrification) and characters that had already been part of principle-based chemistry for the past century.

§ § §

Aside from addressing the central role played by chemistry in the mineralogy of Walker and his contemporaries, this thesis has also touched upon a variety of historiographical points relevant to the study of the nascent earth sciences as they were practiced during the Enlightenment. The first was that the chemistry which Walker used to obtain mineralogical and geological data was principle based. Judging by his sources and by the lectures and publications of his Edinburgh colleagues, these principles played a dominant role in eighteenth-century chemical experimentation. This being the case, only a small fraction of the secondary literature in the history of chemistry addresses this subject. A particularly significant point when one considers that this 'chemical' conception of the earth can easily be traced back to the seventeenth century (Conclusion Plate I). Some of the authors who have treated this area were mentioned throughout the previous chapters, but the most comprehensive studies were those of Duncan, Beretta, Donovan and Oldroyd. The deficiency of research on this topic suggests that there is a large historiographical gap between chemistry as practiced in early modernity and chemistry as envisioned by modern historians. The reason for this gap can be attributed to the widespread interest in pneumatic chemistry's involvement with the new French nomenclature and Lavoisier's conception of oxygen. Even though it is true that later eighteenth-century French chemists did use 'airs' to create a nomenclature that eventually proved to be more convenient, this does not negate the fact that their contemporaries placed more value on 'fluids' that were saline than those that were aerial. This point is well illustrated by the fact that Bergman, a leading eighteenth-century chemist, spent the bulk of his later years concentrating on Salts and assigned the pneumatic experimentation to his assistant Scheele.

As the work of Holmes and Maehle demonstrate, one of the few places where saline experimentation has received the most attention is in the history of medicine—particularly in the area of pharmacology. These two authors emphasise that Enlightenment therapeutic practices were based upon a form of humouralism that sought to balance bodily liquids. This coupled with the fact that chemistry was primarily taught in Scotland's Medical Schools clearly explains why Edinburgh's chemists were fascinated with mineral wells and saline solutions. It also shows the dual authority given to both natural and laboratory productions. Even though the social aspects of saline 'cures' have been studied by Porter and Risse, little has been done to address the impact that medical epistemologies had upon the chemical vocabulary and nomenclature that were used to classify and define minerals. Nor have there been any studies which seek to address the effect that such a medically orientated context had upon the naturalists who approached the earth as a physician would approach a patient's body—especially in relation to the most accessible and

The Chemistry of the Earth
Engraving of Ambrose Godfrey Hanckwitz (1660-1741)
by George Vertue which is based on a 1718 oil painting by Johnann Rudolf Schmutz.
Eddleman and Fisher Collections
Chemical Heritage Foundation
Philadelphia, Pennsylvania

Even though the late seventeenth-century chemists emphasised their break with Aristotelian elements and 'spagyricks', they still demonstrated a keen interest in the earth's structure. This is well illustrated in the volcanic explosion in the engraving above. Hanckwitz was one of Boyle's assistants and a fellow of the Royal Society of London. He was primarily known for his work on phosphorus—a substance associated with volcanic eruptions.

obvious representations of the earth's humours: the ocean and mineral wells. Tangentially, such dual interaction between organic and inorganic chemical language and epistemologies suggests that more work needs to be carried out on chemistry's metaphysical underpinnings.[1]

As Walker's own work demonstrates, chemistry was used upon mineral-wells to 'diagnose' the minerals that could be found in their vicinity and to 'analyse' the ocean's salinity levels in relation to the earth's age. The use of saline solutions in this manner is a particularly notable point when one considers Duden's suggestion that much of the diagnostic language that modern historians have interpreted to be metaphorical actually might have been meant literally by eighteenth-century physicians. Many more connections in this area could be made, especially on how the medical use of Salts, Earths and Metals influenced how naturalists perceived mineral formation, precipitation, earthquakes and volcanic eruptions. However, the potential source material for these topics is vast. One of the advantages of my thesis was that it primarily focused on one person. In order to study how the medical context of chemistry influenced the nascent earth sciences, a more radical revaluation of primary chemistry sources will have to be pursued. Moreover, such a study could not be sustained unless the historiography of chemistry is reconfigured to embrace the plethora of unexplored sources, methods and beliefs that eighteenth-century chemists used to approach experimentation—both in the lab and *in situ.*

Turning to Walker's conception of the earth's form, similar historiographical points could be made. A large percentage of the books in his library and the sources that he cited in his lectures are not the same as those that are often mentioned in works that treat the history of the earth sciences. This thesis has shown that a great many mineralogists who influenced Walker's thoughts in this area remain ensconced in the same anonymity experienced by his chemical sources. At the initial stages of my research, this made reading his work a rather surreal experience, especially when so many of his sources were not immediately recognisable. There were many times when I had to ask myself whether or not I was reading a list of pseudo-authors that belonged to one of J. L. Borges' short stories. Thankfully, my research proved this suspicion incorrect. Aside from their influence in Edinburgh, the names of these seemingly esoteric sources were frequently cited in the *Philosophical Transactions*,

[1] Indeed, a few studies have already looked at this area: J. Geyer-Kordesch, 'George Ernst Stahl's radical Pietist medicine and its influence on the German Enlightenment', in A. Cunningham and R. French, *The medical enlightenment of the eighteenth century* (Cambridge: 1990), 67-87. R. French, 'Sickness and the soul, Stahl, Hoffmann and Sauvages on pathology', in Cunningham and French (1990), 88-110. R. Knoeff, *Herman Boerhaave (1668-1738): Calvinist Chemist and Physician* (Amsterdam: 2002).

the correspondence of Joseph Banks and the many Latin based journals and books published in Scadanavia, Germany and France. Additionally, many of Walker's sources went through numerous editions in Britain alone. Yet, as Chapter 4 so clearly demonstrated, the mineralogical works that shaped Walker's canon receive little to no attention from historians.

Perhaps the simplest explanation for this situation is that so many histories of the earth sciences are interested in tracing the foundations of 'geology'—a subject that did officially not exist in the Edinburgh natural history syllabus until Walker introduced it in 1782. Prior to this time, most of the studies that treated the earth's structure were subsumed under the subject of mineralogy, which was in turn the domain of the chemistry and *materia medica* professors of the Medical School. This was not only the case at the beginning of the century, but continued right up to the time that Walker died; a point that is well evinced by the detailed discussions of minerals and strata contained in the chemistry lectures given by Joseph Black from the 1770s to 1790s. Since Walker held strata to be chemical formations, it was his mineralogy, and the chemistry it was based upon, that laid the foundation for how he interpreted the natural 'phenomena' that he discussed in his geology lectures. He then used this perspective to interpret his own observations (especially from the Highlands) and the travel accounts and theories of the earth that he read. The presence of such an epistemological hierarchy means that he only had limited use for 'theoretical' authors like Buffon, or even Whitehurst. Thus, when lecturing on geology, he basically culled empirical observations from their books and used them as he saw fit within his own epistemology.

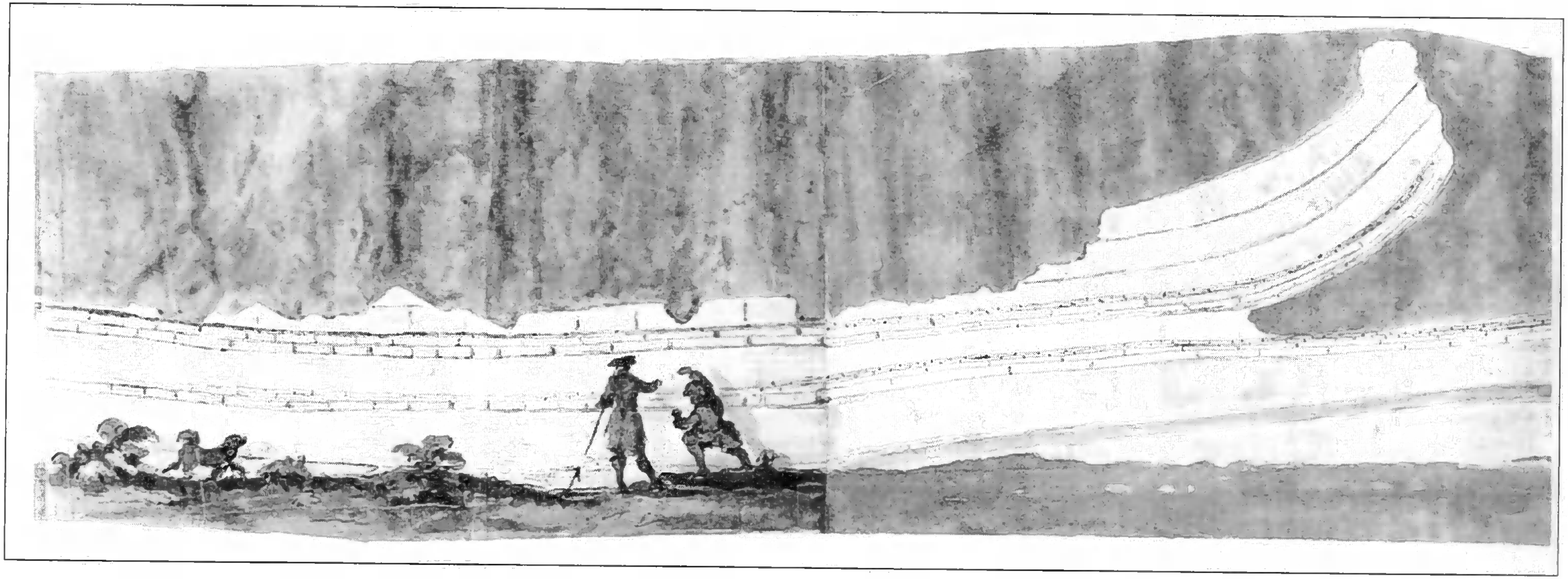
Another reason why Walker's mineralogical sources receive little attention is because they do not fit within the evolutionary historiography so often thrust upon early modern works that treat the composition or structure of the earth. This approach seeks to identify the writers who proposed theories that tried to explain the physical *causes* of volcanoes, strata and extraneous fossils in relation to historical time. Aside from the fact that many of these eighteenth-century 'forerunners' were philosophically radical francophones (Buffon, La Mettrie, Diderot and d'Holbach), Walker's work suggests that such proto-evolutionary authors received little credence in Edinburgh because their theories could not be supported by direct observation or explicit empirical examples. Such a context is what led James Hutton to maintain his own mineralogical collection and to cite empirical data that lined up with the principle-based chemistry being pursued in the Medical School. Indeed, when considered in light of the sources mentioned in Walker's geological lectures, Hutton's pre-Playfairian discussions of the of the earth's crust draw from the same chemical epistemology that shaped Jameson's early assertions about the formation of primary strata. However, such similarities are easily missed when Hutton's work is removed from its intellectual context and placed within an evolutionary historiography.

When Walker's 'geology' is removed from such evolutionary preconceptions and placed in conversation with the sources and the local reality of eighteenth-century Edinburgh, a different image emerges. Instead of interpreting geology through the mechanical imagery of authors like Buffon and John Playfair (or even later authors like Lyell and Darwin himself), it becomes a much more organic pursuit that has strong links to the language, methodology and epistemology of the experimental chemistry being conducted in the Medical School. When concepts of strata and extraneous fossil formation are placed in conversation with this context, the chemical composition of the individual stones, minerals, and spas become equally, if not more, important. Such a historiographical approach reveals that objects formed within the human body were not simply seen as analogues or metaphors of objects found in nature. In many cases, their chemical content allowed for direct ontological comparisons to be postulated. Thus, the methods used for examining bladder stones were the same as those employed upon stones found in the earth; likewise, the saline based humoural experiments performed upon bodily fluids were often the same as those used on the 'earthly fluids' found in local mineral wells.

This medical epistemology also spilled into a wide variety of industrially and artistically related disciplines that proved to be quite relevant to questions about the earth's structure. The most obvious industrial example discussed in this thesis was Higgins' application of Black's chemistry to different types of cement. His experiments in this area allowed Walker to use chemistry to approach stratigraphical gluten and concretions in the same manner that an architect would look at the bricks and mortar. This sort of chemically-influenced linguistic imagery of Walker and Edinburgh's other chemists also had an impact upon the visual images produced at the time, especially in the water colours painted by John Clerk Eldin during the 1780s (although it must also be noted that other painters also attended Walker's natural history course). In addition to concentrating on several topics that would have interested Edinburgh's mineralogists (basalts and limestone for instance), he often portrays underground strata as either straight or curving brick walls. He not only employs this practice in his painting entitled 'Salisbury Crags' (Conclusion Plate II), which depicts the magmatic intrusion made famous by Hutton's *Theory of the Earth*, but also in paintings where he wanted to illustrate the composition or texture of strata. Also included in this lot is, 'Unconformity at Jedburgh, Borders', the picture popularised by Stephen Jay Gould's work on Hutton.

Linking geology to the mineralogy and chemistry taught in the Medical School also legitimises a wide array of works and personalities that the evolutionary model has ignored. As Walker's own library reveals, there are a plethora of primary books and articles that have yet to be addressed by historians. Add to this the lecture notes and correspondence (published and archival) of Scotland's mineralogically minded medical professors who taught throughout the entire eighteenth century. Although this thesis only treated Walker, Cullen, Black, Plummer and Alston, many more could be added to the list. Concentrating on medically related personalities also takes the practice of geologically relevant activities out of the hands of an elite and prescient few 'forerunners' and places it in the domain of the numerous medically trained professionals (physicians, surgeons, apothecaries and midwives) who not only lived in university towns, but also in the countryside parishes of the Lowlands and parts of the Highlands. Added to this group of chemically literate professionals would be clerics like Walker and other merchants and industrialists whose livelihood depended upon mineralogical commodification (Conclusion Plate III).

Even though this thesis focused on Walker's intellectual context, other studies need to be conducted to see how much professors like him depended upon the local knowledge provided by the chemically trained professionals mentioned above—or even by the lapidaries who gathered minerals for apothecaries and mineralogical collectors. Likewise, much work remains to be done on the geological 'greats' like Hutton and Playfair who by their own admission were dependent upon information supplied to them by local observers. Furthermore, the scope of the nascent earth sciences needs to be widened so that it includes the Medical School students who went on to live abroad as ambassadors, naval officers, explorers, missionaries and merchants. Walker's correspondence and the letters read at the Student Natural History Society clearly demonstrate that these travellers had their own conceptions of mineralogical composition and that they made detailed terraqueous observations that were couched within the epistemology they had learned back in Edinburgh.

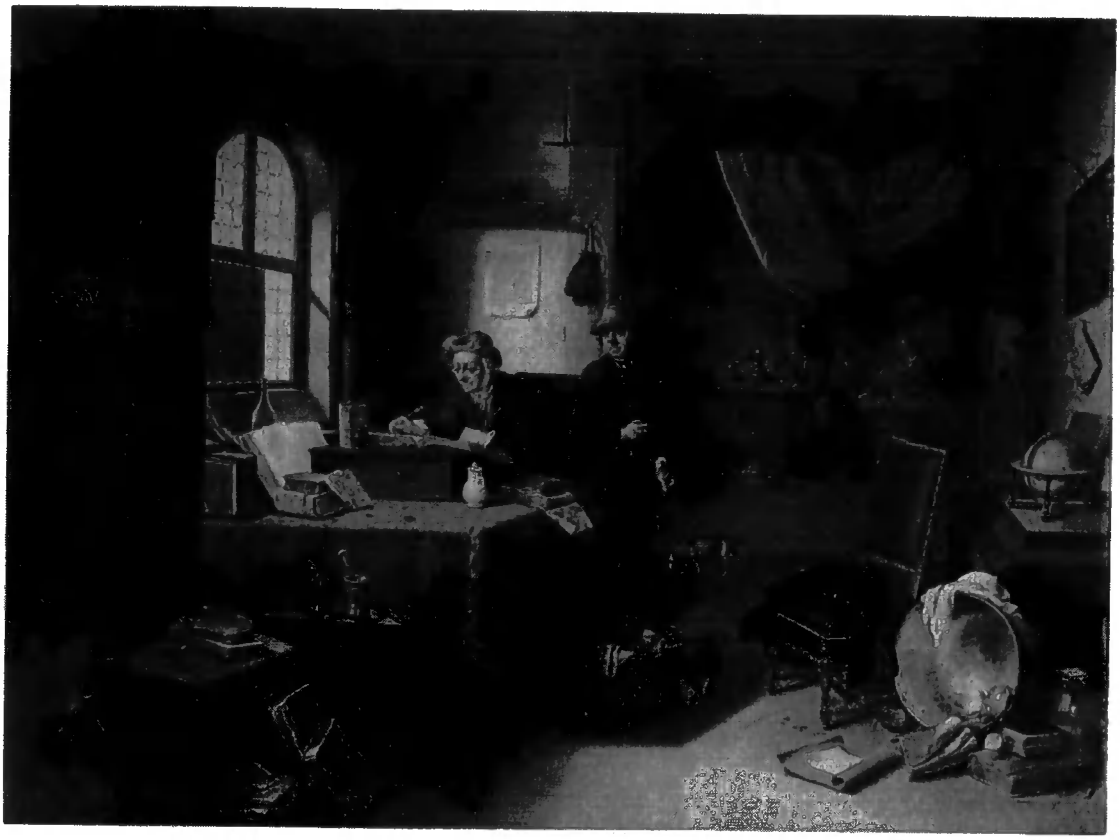


Salisbury Crags, Edinburgh**, c. 1785**
John Clerk of Eldin (1728-1812)

Craig, G.Y, *et al.* (eds), *James Hutton's theory of the earth. Reproductions of drawings*... (Edinburgh: 1978), 28.

A brick and mortar motif occurs throughout many of Clerk's stratigraphical drawings.

Conclusion Plate II.



***The Village Chemist*, 1760**
Justus Junker (1703-1767)
Eddleman and Fisher Collections
Chemical Heritage Foundation
Philadelphia, Pennsylvania

In the Lowlands of Scotland and throughout various cities, towns and villages of the Netherlands, Germany and Scandinavia, there were a substantial number of medically trained professionals who practiced principle-based chemistry. Many of them turned their 'art' to minerals and this means that there was a wide variety of people who contributed to the nascent earth sciences.

In the end, this study of Walker has shown that there are many avenues available to historians who are interested in addressing the intellectual and social corridors that embraced the nascent earth sciences in Enlightenment Edinburgh. In doing so, it has sought to address Roy Porter's assertion that 'historians of science have paid little attention to a major branch of natural philosophy in the eighteenth century: the science of the system of the earth and its products.'[2] Even though this statement still rings true, this thesis has demonstrated that Walker and his contemporaries devoted an enormous amount of time and energy to understanding the structure and composition of the earth. Even though many of them were economically rewarded for their efforts, the fact still remains that they truly enjoyed making detailed observations of the natural world; an assertion that can be supported by Walker, who continued to write and collect data well after he had secured his position in the university. This suggests that he was both personally and professionally interested in the 'Mass of the Matter of the Globe' and in being a lifelong student of the natural history of the earth.

> *After a Journey which has afforded me a great deal of Pleasure, tho' mixed with some Hardships, I am at length arrived at this Place, having made a compleat Tour through all the western Islands. Tho' I have spent four months among them, and looked round me every where as attentively as I could, yet they are so numerous, and of so great Extent, that it is but a transient View that a Person can acquire of them in that Time.*

— John Walker to Baron Mure, 4 August 1764 (Fort Augustus)[3]

[2] R. Porter, 'The terraqueous globe', in G. S. Rousseau and R. Porter, *The ferment of knowledge* (Cambridge: 1980), 285-324; quotation taken from page 285.
[3] NLS Mure of Caldwell Correspondence 1770-72 MS 4943 f. 98-99

APPENDICES

APPENDIX I

William Cullen's 1753 'Doctrine of Salts' Classification Based on Dobbin's 'A Cullen Manuscript of 1753'

SIMPLE SALTS
- A. Acids
  - 1. Vitriolic Acid (Species)
  - 2. Nitrous Acid (Species: Specific gravity creates many varieties)
  - 3. Muriatic Acid (Species: Varieties not yet confirmed)
  - 4. Vegetable Acid (Species)
    - a. Native (variety)
    - b. Distilled (variety)
    - c. Fermented (variety)
- B. Alkalis
  - 1. Fixed
    - a. Vegetable (species)
      - 1) *Cineras Clavellati* (variety)
      - 2) Salt of Tartar (variety)
      - 3) Wine of Lees (*cendres gravellées*) (variety)
      - 4) Fixed Nitre (variety)
    - b. Fossil (species)
      - 1) *Natrum* or *Nitrum Veterum* (variety)
      - 2) Borax (variety)
      - 3) Incinerated Sea Plants [including soda] (variety)
  - 2. Volatile (species)
      - 1) Salt Ammoniac (variety)
      - 2) Other Animal Substances (variety)

COMPOUND SALTS
- 1. Vitriolic Acid Joined to:
  - a. Vegetable Alkali (Vitriolated Tartar)
  - b. Fossil Alkali (Glauber's Salt)
  - c. Volatile Alkali (Vitriolic Ammoniac)
- 2. Nitrous Acid Joined to:
  - a. Vegetable Alkali (Common Nitre)
  - b. Fossil Alkali (Cubic Nitre)
  - c. Volatile Alkali (Nitrous Ammoniac)
- 3. Muriatic Acid Joined to:
  - a. Vegetable Alkali (Digestive Salt of Sylvius)
  - b. Fossil Alkali (Alimentary Salt)
  - c. Volatile Alkali (Muriatic or Common Ammoniac)
- 4. Vegetable Acid Joined to:
  - a. Vegetable Alkali (Regenerated Tartar)
  - b. Fossil Alkali (Salt of Seignette)
- c. Volatile Alkali (Vegetable Ammoniac)

APPENDIX II

Cullen's 1753 Chemistry Canon

Contents

A. Essay* on Cullen's 1753 Chemistry Cannon

I. Introduction

In this essay I argue for a re-evaluation of the received canon of eighteenth-century chemistry 'texts'. I do so by examining a 1753 paper written by William Cullen, the University of Edinburgh's Professor of Chemistry. In the first section, I discuss the 'texts' Cullen used to support his argument. In identifying these texts, it will become clear that they are not the standard sources treated by histories of chemistry. The second section of this essay shows that this situation is the result of a chemical historiography that is unevenly influenced by the supposed events that led up to the 'Chemical Revolution' at the end of the eighteenth century. I suggest that such a historiography is insufficient because it does not focus on the texts valued by leading eighteenth-century chemists like Cullen. In the third section, I offer a rough sketch for a new historiographical approach that seeks to excavate the texts that are representative for Cullen's time period.

II. Cullen's 1753 "Text-books"

When looking at eighteenth-century chemistry texts, the first question that might arise is "Why Cullen?". A simple answer to this question would state that he was a professor at the University of Edinburgh – arguably the leading scientific institution of the later Enlightenment. His contributions to both chemistry and medicine played a central role in university's reputation in both Britain and on the continent. In 1753, he presented a paper on the classification of Salts to the Edinburgh Philosophical Society. He wrote it to demonstrate his chemical competency and to impress

* Originally presented as 'Cullen's Cannon: A Re-evaluation of Chemistry Texts at Edinburgh's Medical College, *circa* 1753', at the British Society for Eighteenth Century Studies 31st Annual Conference (4-6th January 2002) at Queens' College, Cambridge.

Edinburgh's enlightened literati. The sources that he cites were therefore intended to communicate his familiarity with the chemistry texts valued by the numerous chemists that would have been sitting in the audience. As it was Cullen's expressed aim to create his own chemistry textbook, one of the very reasons that he presented his 1753 paper was to receive feedback as to which chemistry texts might help him achieve this goal. Cullen's paper mentions over twenty sources. A close examination of these texts demonstrates that he drew from four overarching trends.

1. Non-English Texts: Only about a third of these 'texts' are written in English. The remaining two thirds are written in either Latin or French. Furthermore, this division also applies to the number of British authors, making the majority of Cullen's sources continental. Futhermore, these non-English sources were mostly from continental Europe—France, Holland and German principalities being the most prominent, with a few others from Italy and Russia.

2. Texts that Treated Saline Chemistry: The very goal of Cullen's paper was to present a classification of Salts – that is, substances that can be dissolved in water. The established literati of his Edinburgh audience were quite familiar with this form of analysis. The foundational work for this type of chemistry was Georg Ernst Stahl's *Specimen Becherianum* and Cullen duly mentions it. Saline analysis was also utilised by Pierre Joseph Macquer and, to an extent, Boerhaave.

3. **Chemically Related Texts:** A third trend exhibited in Cullen's sources is that many of the authors were not writing about chemistry *per se*. They were texts whose application of chemistry made them inherently important for the field. Included in this lot were sources taken from books on industry, such as William Brownrigg's *The Art of Making Common Salt*; books from pathology, such as John Pringle's *Observations on the Diseases of the Army*; and books from natural history, such as Linnaeus's *Systema Naturæ*.

4. Journal Articles: During this time, various European academies published journals that contained essays and letters that specifically addressed chemistry. They were often gathered into volumes and then published as books in themselves. The articles cited by Cullen came from such bound journals. He specifically mentions *Commentaries of the Imperial Academy of St. Petersburg*, *Memoirs of the Royal Academy of Sciences* of Paris and *Proceedings of the Royal Academy of Sciences* in Berlin.

III. Questioning Chemical Historiography

In addition to his 1753 paper on Salts, Cullen's lectures from this period demonstrated that saline experimentation was just as important as analysis by heat. Even though he would become more interested in latent heat and 'airs' in the mid 1760s, he consistently employed saline chemistry throughout his entire career. The same can be said of Cullen's most famous student Joseph Black and for other students. The importance of this solution-based chemistry can not only be seen in the letters that he wrote to his academic friends and patrons, but it has been demonstrated by several twentieth century authors, the most thorough being Arthur Donovan's 1976 work entitled: *Philosophical Chemistry in the Scottish Enlightenment.* Cullen's promotion of saline analysis not only affected the practice of chemistry, it also affected the practice of fields which depended upon chemical analysis. At the time, these fields included mineralogy, botany, pharmacology, georgics and industry. Such a use of chemistry was not confined to Cullen's followers in Scotland. The articles he mentions in his 1753 lecture demonstrate its influence in the scientific academies of Paris, Berlin and St. Petersburg.

Judging by Cullen's chemistry texts, it would seem that saline chemistry would be a frequent topic of inquiry for historians of chemistry and for historians of agriculture, medicine, industry and natural history. Strangely, this is not the case. In the history of chemistry, the reason for this is historiographical and was summed up over a decade ago by the Yale historian Larry Holmes in his book *Eighteenth-Century Chemistry as an Investigative Enterprise.* There, he states the following: "Historians of science have found it difficult to view eighteenth century chemistry as anything other that the stage on which the drama of the chemical revolution was performed." Such a fascination with the development of Lavoisier's nomenclature concentrates on the chemistry of "heat" and "airs", thereby inherently shifting the focus away from the aqueous experiments of saline analysis. Holmes was not the first to identify this situation, nor will he be the last. The works of John Christie and Michael Barfoot also emphasise similar points.

One of the reasons why it is easier for a historian to defer to the 'Chemical Revolution' historiography is simply because eighteenth-century chemistry is not an easy topic to study and because it lacks a standard vocabulary and nomenclature. One of the advantages of the 'Chemical Revolution' approach is that it gives a focal point to historians trying to cut through a maze of chemical vocabulary. Indeed, this approach has provided a helpful narration of the intellectual factors that led up to certain aspects of Lavoisier's programme. However, this approach has been in place for the past two hundred years and its dominance seems to have eliminated discussion of the very texts that were being read by practising chemists

Even though I am focusing on Cullen's sources, the same situation can be seen in the authors cited in the lectures and works of his University of Edinburgh contemporaries. If one were to try to find secondary literature on frequently cited authors like Stahl, Gmelin, Pott or Wilson, one must met with an ominous silence. Further afield, Norma E. Emerton also points out that the lack of studies on the sources of chemists in Baltic countries, German principalities and France indicate that the same problem exists there also. Not only is there an absence of secondary literature, there is also the absence of reprinted editions of major authors like Stahl, Pott, Boerhaave and Macquer. For that matter, an edition of Cullen's lectures is also quite hard to obtain. The lack of such texts creates a vicious circle in which constant attention is paid to sources that have already been accepted as representative. Even if their role is criticised, the very fact that they receive attention still indirectly confirms their 'canonical' position.

IV. Three Ways to Re-evaluate Eighteenth-Century Chemistry Texts

There are many routes that could be taken if one were interested in re-evaluating the history of Enlightenment chemistry. One could use the linguistic approach suggested by Maurice Crosland in his *Historical Studies in the Language of Chemistry* or the symbolic approach of Marco Beretta's *The Enlightenment of Matter*. There is also the social constructivist approach taken by Stephen Shapin in his *A Social History of Truth* or the "public knowledge" approach used by Jan Golinski in his *Science and Public Discourse*. However, no matter which method one chooses, it is most often the case that the actual texts under discussion are those that were originally valued by the 'Chemical Revolution' historiography—more simply stated, these alternative approaches are based on chemistry texts that have already been determined to be representative. This being the case, a historiography that seeks to re-evaluate the role of chemistry texts is still needed. In what remains of this essay, I propose three sources that can provide a scholar with an overview of which textbooks were valued by eighteenth-century chemists—and in each case use Cullen's paper and its context to illustrate my suggestions. The three sources are: (1) Personal Manuscripts, (2) Journal Articles and (3) Library Listings.

1. Personal Manuscripts: This approach would involve consulting letters, personal notations and lecture notes to see which texts are playing an important role. It is a tricky process because it is tempting to ignore seemingly abstruse references that are not mentioned in standard histories of chemistry. A case in point of this is the manuscript collection of Cullen's early career housed in the University of Glasgow. In these documents, Cullen continually cites authors who wrote about saline chemistry and mineralogy. In the manuscript notes for his lectures where he gives his own history of chemistry, he cites works that he believes valuable to the field and highlights the interaction of chemistry and natural history. In fact, many of the authors are the same as those who appear his 1753 paper—Stahl, Homberg, Hoffman and Pott for example. Yet even though Cullen thought such sources to be important enough to give to his students, the modern scholar is left a loss when trying to locate articles on these authors or even reprintings of their works. This forces a researcher to use the more accessible sources that conform to the Chemical Revolution historiography.

2. Journals: Specific studies regarding the content and role of eighteenth-century scientific journals are few. Yet, as Cullen's 1753 paper demonstrates, a prevalent source for eighteenth-century chemistry was articles taken from journals. The several articles that he cites from the *Memoirs of the Royal Academy of Sciences* were actually written from the years 1666-69 and were published as a multi-volumed set from 1731 to 1736. Unfortunately, aside from Holmes, there has been little work on the chemistry of Hoffman, Homberg and du Monceau as portrayed in the *Memoirs*. The same can be said of Stahl's work in the *Proceedings of the Royal Society of Sciences* in Berlin and of Gmelin's work in *Commentaries of the Imperial Academy of St. Petersburg*. Cullen's paper also intimates that he was using periodical publications such as the *Medical Essays and Observations* of the Edinburgh Philosophical Society and the *Dispensatory of the Royal College of Physicians, London*. Sadly, secondary material on these publications is also lacking. Moreover, the only works I have found that treat chemistry's role in journals are the few which investigate eighteenth-century mineral well-analysis—which is another chemistry source grossly overlooked by historians.

3. Library Indices: These comprise both personal and university libraries. Large personal libraries were most often amassed by Scottish Lords and gentlemen who could afford to purchase expensive books. They often employed highly educated men to help them ascertain useful scientific books for their collections. Cullen was not exception to this rule and he functioned as an advisor to the Duke of Argyll, the Duke of Hamilton and Lord Kames. In the lists of these collections, there are not only books that specifically address the practice of chemistry, but also books that treat agriculture, mineralogy, mining, metallurgy, botany and gardening—all sources that receive little attention by historians of chemistry. In addition to aristocratic and gentlemanly bibliophiles, university library collection indices from the eighteenth-century, particularly Edinburgh and Glasgow, demonstrates that they stocked many of the books and journals that Cullen references in his paper—especially some of the seemingly obscure texts that are not treated by historians. Investigating which books were seen fit to deposit in the library for public access gives another clue as which texts were valued in Enlightenment Edinburgh.

Conclusion

In this essay I have used William Cullen to suggest that the received canon of eighteenth-century chemistry texts needs to be re-evaluated. I specifically focused on Scotland by discussing Cullen's 1753 paper on the Doctrine of Salts. I first identified his sources and then demonstrated how these sources have been ignored by historians because they do not fall into the 'Chemical Revolution' historiography so often used to interpret the texts of eighteenth-century chemistry. I then proceeded to critique this historiography and then suggested three sources that could be used for excavating representative chemistry texts. These included a textually focused reading of (1) Manuscripts, (2) Journals and (2) Library Indices. Naturally, looking at these sources will probably uncover other interesting sources that can be used to investigate which texts played an important role in the over-arching enterprise of chemistry. Even though Scotland was my focus, this approach might also be beneficial to those studying the history of chemistry in other contexts.

B. Table of Sources Listed in Cullen's 1753 Doctrine of Salts Paper

NAME	WORK	PUBLICATION	LANGUAGE
Johannes Bohn (1640-1718)	*Dissertationes chymico-physicae, chymiae finem, instrumenta et operationes frequentiores explicantes ... Quibus accessit ejusdem tractatus ... de aeris in sublunaria influxu* Lipsiae : C. Göz for Joh. Friderici Gleditschii, 1685 [Wellcome]	Leipsig: 1685	Latin
Hermann Boerhaave (1668-1738)	*Elementa chemiae / quae anniversario labore docuit, in publicis, pravatisque, scholis Hermannus Boerhaave. Cum tabulis aeneis.* Lugduni Batavorum : Sumtibus Joannis Rudolphi Imhof, 1732. [Wellcome]	Leyden: 1732	Latin
Hermann Boerhaave (1668-1738)	'Treatise on Menstruums'		
Georg Ernst Stahl (1660-1734)	*Specimen Becherianum*	Leipzig 1703	Latin
Georg Ernst Stahl (1660-1734)	*Miscellanea berolinensia ad incrementum scientiarum : ex scriptis Societati Regiae Scientiarum exhibitis edita Tom. 7* Berlin : Johan. Christ. Papenii, 1710 [Wellcome]	Berlin: 1710	Latin
Johann Juncker	*Conspectus Chemiœ* [See Cole?]	Halle: 1730	Latin
Pierre Joseph Macquer (1718-1784)	*Élémens de chymie théorique* Paris : J.T. Hérissant, 1749 [Wellcome]	Paris: 1749	French
Pierre Joseph Macquer (1718-1784)	*Elémens de chymie-pratique. Contenant la description des opérations fondamentales de la chymie, avec des explications & des remarques sur chaque opération / Par M.Macquer* Paris : J.-T. Hérissant, 1751 [Wellcome]	Paris: 1751	French
Frederick Hoffman (1660-1742)	*Petri Poterii Opera omnia practica et chymica / cum annotationibus et additamentis utilissimis pariter ac curiosis. Friderici Hoffmanni, filii ... Accessit nova doctrina de febribus, ex principiis mechanicis solide deducta* Venetiis : Balleoniana, 1741 [Wellcome]	Venice: 1741	Latin
J. G. Gmelin (1709-1755?)	*Commentarii Academiae scientiarum imperialis Petropolitanae. 1726-1740 Tom. V.* Petropoli, 1728-1740 [Glasgow]	St. Petersburg: 1728-1740	Latin
H. L. Du Hamel du Monceau (1700-1782)	"The Basis of Sea Salt" *Mémoires de l'Académie royale des sciences* [Paris] La Haye ; Amsterdam, 1731-1736 [Wellcome] Covers the years 1666-1699. Published from 1731-1736	Amesterdam: 1736	French
J. H. Pott (1692-1777)	*D. Johannis Henrici Pott Exercitationes chymicae ... / sparsim hactenus editae, jam vero collectae, restitutae, a mendis repurgatae, variisquenotis, experimentis et discussionibus ab auctore adauctae, illustratae* Berolini : Apud J.A. Rüdigerum, 1738 [Wellcome]	Berlin: 1738	Latin
Andrew Plummer (1697-1754)	Possibly referring to articles in *Medical essays and observations* or to lecture notes.	Edinburgh	English
E. F. Geoffroy (1672-1731)	*Mémoires de l'Académie royale des sciences* [Paris] La Haye ; Amsterdam, 1731-1736 [Wellcome] Covers the years 1666-1699. Published from 1731-1736 See esp. "Sur la nature des sels", 1686-1692 (Paris: 1733), Vol. II, 252-255.	Amesterdam: 1736	French

NAME	WORK	PUBLICATION	LANGUAGE
Thomas Short (1690?-1772)	*An essay towards a natural, experimental, and medicinal history of the principle [sic] mineral waters of... Northern counties... Being the second volume of the mineral waters of England* Sheffield: : Printed for the author, by John Garnet ..., 1740 [Wellcome]	Sheffield: 1740	English
William Brownrigg (1712-1800)	*The art of making common salt, as now practised in most parts of the world; with several improvements. Proposed in that art, for the use of the British dominions* London : C. Davis (and others), 1748. [Wellcome]	London: 1748	English
John Pringle (1707-1782)	*Observations on the diseases of the army, in camp and garrison. In three parts. With an appendix, containing some papers of experiments, read at several meetings of the Royal Society ...* London : Printed for A. Millar, and D. Wilson...and T. Payne ..., 1752. [Wellcome]	London: 1752	English
John Hill (1714 fl.-1775?)	*A history of the materia medica. Containing descriptions of all the substances used in medicine, their origin..., their chymical analysis...* London : Printed for T. Longman, C. Hitch and L. Hawes ... [et al.], 1751. [Wellcome] *A review of the works of the Royal Society of London, containing animadversions on such of the papers as deserve particular observation ... under the several heads of arts, antiquities, medicine, miracles, zoophytes, animals, vegetables, minerals* London : R. Griffiths, 1751 [Wellcome]	London: 1751 London 1751	English
Guillaume Homberg	*Mémoires de l'Académie royale des sciences* [Paris] La Haye ; Amsterdam, 1731-1736 [Wellcome] Covers the years 1666-1699. Published from 1731-1736 See esp. "Essays de chimie; article premier. Des principles de la chimie en general", (2nd ed, Paris: 1720), 40-42.	Amsterdam: 1736	French
George Wilson (b. 1631?)	*A compleat course of chymistry; containing not only the best chymical medicines, but also great variety of useful observations* The 4th ed. / carefully cor. London : Printed for D. Browne, etc., 1721. [Wellcome] [Glasgow]	London: 1721	English
Royal College of Physicians, London	The dispensatory of the Royal College of Physicians, London / translated into English with remarks, etc. By H. Pemberton, M.D. ... 3rd Edition. London: Printed for T. Longman and J. Nourse , M.DCC.LI. [1751] [Wellcome]	London 1751	English
Robert Boyle (1627-1691)	*The works of the honourable Robert Boyle in five volumes. To which is prefixed the life of the author.* London : Printed for A. Millar ..., 1744 [DUL]	London: 1744	English
Carl Linnaeus	*Systema naturae sistens regna tria naturae : in classes et ordines genera et species redacta* Ed. sexta / emendata et aucta. Stockholm : [L.L. Grefing for G. Kiesewetter], 1748. [Wellcome] The volume on minerals.	Stockholm: 1748	Latin

C. Cullen's Rudimentary Mineralogy, *c.* 1750s

<table>
<tr><th>Rocks†</th><th colspan="2">Earths‡</th><th colspan="4">Stones</th></tr>
<tr><td rowspan="13">Vitrescible
Calcareous
Argillaceous
Talky</td><td rowspan="2">Moist Surface/ Viscid</td><td>Marls</td><td rowspan="3">Powdery</td><td rowspan="3">Concretions
Fragments</td><td colspan="2" rowspan="3"></td></tr>
<tr><td>Clays</td></tr>
<tr><td rowspan="2">Dry Surface/ Friable</td><td>Ochres</td></tr>
<tr><td>Tipelas</td><td>Solid</td><td>Simple</td><td colspan="2">Gypseous
Freestone
Rockstone
Granite</td></tr>
<tr><td colspan="3" rowspan="9"></td><td rowspan="9">Structured</td><td rowspan="3">Determined</td><td>Septassia</td></tr>
<tr><td>Liderochit</td></tr>
<tr><td>Calculi</td></tr>
<tr><td rowspan="2">Milky</td><td>In Nodules</td></tr>
<tr><td>In Strata</td></tr>
<tr><td rowspan="2">Coloured</td><td>With Crusts</td></tr>
<tr><td>Without Crusts</td></tr>
<tr><td rowspan="2">Clear</td><td>In Nodules</td></tr>
<tr><td>In Strata</td></tr>
</table>

† Made out of Primary Earths.
‡ In this case, 'Earths' mean 'soil' and should not to be confused with Primary Earths.

APPENDIX III

Contents

A. Walker's Mineralogical System Compared to Bergman's
B. Table of Pre-Walker Chemical Mineralogies

A. Walker's Mineralogical Systems Compared to Bergman

WALKER 1781[1]	BERGMAN 1783[2]		WALKER 1790[3]	WALKER 1795ish[4]
Terrae Class 1	Earths Class 1	Calcareous Species? Order?	Terrae Class 1	Terrae Class 1
Calcarea Class 2			Clacarea Class 2	Calcarea Class 2
Gypsea Class 3		Magnesia	Gypsea Class 3	Gypsea Class 3
Phosphorea Class 4			Ponderosa Class 4	Phosphorea Class 4
Fusoria Class 5			Phosphorea Class 5	Zeolitica Class 5
Silicea Class 6		Argillaceous	Amandina Class 6	Ponderosa Class 6
Steatitica Class 7			Silicia Class 7	Amandina Class 7
Apyra Class 8			Steatitica Class 8	Silicea Class 8
Zeolitica Class 9		Siliceous	Apyra Class 9	Steatiticea Class 9
Micacea Class 10			Zeolitica Class 10	Apyra Class 10
Petrae Class 11			Micacea Class 11	Micacea Class 11
Saxa Class 12		Heavy	Petrae Class 12	Petrae Class 12
Concreta Class 13			Saxa Class 13	Saxa Class 13
Salia Class 14			Concreta Class 14	Concreta Class 14
Inflammabilia Class 15	Salts Class 3		Salia Class 15	Salia Class 15
Pyritae Class 16			Inflammabilia Class 16	Inflammabilia Class 16
Semimetalla Class 17	Inflammables Class 2		Pyritis Class 17	Pyritis Class 17
Metalla Class 18			Semimetalla Class 18	Semimetalla Class 18
	Metals Class 4		Metalla Class 19	Metals Class 19

[1] *Schediasma Fossilium* (1781)
[2] *Outlines of Mineralogy, translated ... by William Withering.* (Piercy & Jones: Birmingham, 1783)
[3] *Lectures on Natural History* (1790), EUL DC.2.25, f. 62 and *Lecture on Natural History Vol. III* (1790s), Eul DC.2.19, f. 3.
[4] *Systema Fossilium*, Bound MS Glasgow University Library (GUL) MS Gen 1061 (1795 Watermark).

B. Table of Pre-Walker Chemical Mineralogies

LINNAEUS — *Systema Naturae* (1735)

Earths + Stones	Gypseous
	Alkaline + Calcareous
	Argillaceous
	Siliceous
Minerals	Salts
	Sulphurs
	Mercurials
Fossils	Earths
	Concretions
	Petrifactions

POTT 1746/1753 — *Lithogéognosie* (1753)

Earths & Stones	Gypsous
	Alkaline + Calcareous
	Argillaceous
	Siliceous

WALLERIUS 1747/1753 — *Mineralogié* (1753)

Earths	Mineral
	Argillaceous
	Dry
	Sandy
Stones	Calcareous
	Argillaceous
	Vitrifiable
	Rocks
Minerals	Salts
	Sulfurs
	Metals
	Semimetals
Concretions	

DA COSTA 1757 — *Natural History of Fossils* (1757)

Earths (Section 1)	Moist, firm & Smooth (Chapter 1)
	Loose, dry & rough (Chapter 2)
	Com-pounded & Mixed (Chapter 2)
Stones (Section 2)	Found in strata, rough, gritty, dull, etc. (Chapter 1)
	Found in strata, close, solid, dull, no grit, etc. (Chapter 2)
	Marloid? (Chapter 3)
	Colours, polished, not calcareous, no reaction with acids (Chapter 4)
Incomplete	

CRONSTEDT 1758/1770 — *System of* Mineralogy(1770)

Earths (Class 1)	Calcareous (Order 1)
	Siliceous (Order 2)
	Garnet (Order 3)
	Micaceous (Order 5)
	Argillaceous (Order 4)
	Asbestos (Order 7)
	Manganese (Order 9)
	Zeolites (Order 8)
	Fluors (Order 6)
Salts (Class 3)	
Inflammables (Class 2)	
Metals (Class 4)	

BLACK 1767/8 — *Lectures on Chemistry* (1767/8)

Earths (Class 4)	Absorbants
	Gypseous
	Clays
	Flints
	Talks
Salts (Class 1)	
Inflammables (Class 2)	
Metals (Class 3)	
Water (Class 5)	
Airs (Class 6)	

APPENDIX IV

Rev. Dr. John Walker's Correspondence Arranged Chronologically

Manuscript Location Abbreviations

BL	British Library
EUL	Edinburgh University Library
EC	Cornelius Elliot's Catalogue of Walker's Library
GUL	Glasgow University Library
LSL	The Linnean Society of London
NAS	National Archives of Scotland
NLS	National Library of Scotland
RCPE	Royal College of Physicians Edinburgh

1754(-57?)
Walker to T. Birch. BL Add. 4320 ff. 89, 91.

1756
18 February 1756. Dr. C. Garden to Walker. On the 'Principal Correspondence List', EUL La.III.352.

1762
8 January 1762. Walker to Linnaeus. EUL La.III.352/1. (Scott, 1966)
2 February 1762. Linnaeus to Walker. (Scott: 1966; 258-259)
22 February 1762. Linnaeus to Walker. EUL La.III.352/1 ff. 1-2.
12 Oct 1762. Walker to Linneaus. EUL La.III.352/1 ff. 5-6. (Scott: 1966; 260-61).

1763
22 February 1763. Walker to William Cullen. GUL GB 247, MS Cullen 41, Thompson II 729.
20 June 1763. Linnaeus to Walker. In Latin. EUL La.III.352/1 ff. 7-8. (Scott: 1966; 261-62)
25 August 1763. John Hope to David Skene. Ref. to Walker. AUL SC MS 38 f.119.

1764
5 March 1764. Lord Kames to Walker. NAS E 721/7. (McKay: 1980; 6, 230)
21 April 1764. Thomas Pennant to William Cullen. EUL La.III.352/1 ff. 9-10. (McKay: 1980; 7, 230)
30 July 1764. Walker to Lord Kames. NAS E 727/16/2. (McKay: 1980; 7, 230).
8 August [?] 1764 John Ritchie to Walker. EUL La.III.352/1 ff. 3-4.
17 August 1764. Walker to Lord Kames. NAS GD24/1/571/138-139. Printed in (Home: 1807): Book III, 12-16.
24 August 1764. Walker to Baron Mure. NLS Mure of Caldwell Correspondence 1770-72. MS 4943 f. 98-99
10 December 1764. Walker to Lord Kames. EUL La.III.352/1 ff. 11-12. NAS GD 24/1/571/140-145. (McKay: 1980; 8, 231)

1765
8 February 1765. Walker to Lord Bute. EUL La.III.352/1 ff. 13-16. (Withers: 1991; 218). (McKay: 1980; 8, 231).
31 August 1765. John Hope to David Skene Ref. to Walker AUL MS 38.

29 October 1765. John Ellis to Linnaeus. Ref. to Walker. (Smith: 1821/1978: 180)
29 October 1765. William Walison, MD to Richard Pultney. NLS Acc. 9533 No. 314.
16 November 1765. John Hope to David Skene. Ref. to Walker. AUL SC MS 38 f.138 (Withers: 1991; 210)
c.1765. Memorial concerning the proposed Navigation, between the Murray Firth of the Sound of Mull (revised copy). EUL La.III.352/1 ff. 19-21 details

1766
12 April 1766. Walker to Cardross. NLS MS 588, No 1386.
17 September 1766. F. W. P. Fabricius to Walker. EUL La.III.352/1 ff. 22-23.
30 October 1766. Walker to Dr. Pultney. NLS MS Acc. 9533 No. 314. LSL No. 238.
1766. Walker to Dr. C. Lyttelton. BL Stowe 754 f.189.

1767
2 February 1767. Baron Charles Cathcart to Walker. EUL La.III.352/1 ff. 24-25.
28 March 1767. Walker to Joseph Banks. (Dawson: 1958, 849).
1767. Alexander Small to George Clerk. Regarding Walker and his possible bid to be St. Andrews Professor of Church History is in a declining Way. NAS 18/4103.

1768
3 June 1768. Walker to Dr. Pultney. LSL No. 238
Day? October 1768. Dr. Pultney to Walker. NLS MS Acc. 9533 No. 314.
1768 Walker to the Earl of Buchan. NLS MS 14827 ff. 6-7.

1770
14 April 1770. Walker to David Skene. AUL MS 483 ff.48-52. (Withers: 1993; 69)
c. 1770. James Hutton to John Strange. Ref .to Walker. (Withers: 1991; 20)

1771
28 February 1771. Board of Annexed Estates to General Oughton. NAS E 727/63/3.
11 March 1771. Walker to the Commissioners of Annexed Estates. NAS E 727/63/4. (McKay: 1980; 10, 231)
8 [21?] December 1771. William Fraser to Walker. EUL La.III.352/1 ff. 28-29.

1772
23 January 1772. Walker to Joseph Banks. (Dawson: 1958, 849).
29 February 1772. Walker to Lady Kames. NAS GD 24/1/496-503A/629-630.
9 March 1772. Walker to Baron Mure. MS 4945 f. 142-143.
25 March 1772. Lord Bute to Baron Mure. About books sent to Walker. NLS Mure of Caldwell Correspondence,1770-72, MS 4945 f.?.
? March 1772. Walker to Donald MacNicol. EUL La.III.352/1 ff. 30-31.
20 April 1772. John Stuart to Walker. EUL La.III.352/1 ff. 32-33.
14 August 1772. Lord Bute to Baron Mure. NLS Mure of Caldwell Correspondence 1770-72, MS 4945 f. 170-171.
23 August 1772. Dr. John Rogerson to John Clerk [7th son of Sir John Clerk of Pennicuik]. NAS GD 18/5121/3.
7 September 1772. Walker to John Stuart. No MS reference. This letter is mentioned in Stuart's 25 September 1772 letter to Walker.
25 September 1772. John Stuart to Walker. EUL La.III.352/1 ff. 34-35.
22 November 1772. Baron Charles Cathcart [British Ambassador to Russia] to Walker. Presumed to exist. On the 'Principal Correspondence List' of EUL La.III.352.

1773
18 February 1773. Walker to Lord Kames. NAS GD24/1/571/148-156. Partially quoted in Sir George Taylor's note in NLS MS Acc. 9533 No. 314. (Home: 1807): Appendix No. II, 23-37.
30 November 1773. Kames to Walker. Comparison NRAS 1073 Bundle 23 (Private)

1774
12 May 1774. George Clerk-Maxwell to Walker. EUL La.III.352/1 ff. 36-37.
22 November 1774. Baron Charles Cathcart to Walker. EUL La.III.352/1 ff. 38-39.
12 December 1774. Lord Kames to Walker. EUL La.III.352/4 ff. 1-2. (Jones: 1988; 166)

1775
25 February 1775. Walker to Donald MacNicol. No MS reference. This letter is mentioned in MacNicol's letter to Walker on 22 March 1775.
22 March 1775. Donald McNicol [of Lismore] to Walker. EUL La.III.352/1 ff. 40-43
8 November 1775. Walker to Lord Kames. NAS GD24/1/571/146-147. Printed in (Home: 1807): Appendix No. II, 52-55.

1776
29 February 1776. Walker to Lord Kames. NAS GD24/1/571/164-170. Printed in (Home: 1807): Appendix No. II, 56-66.
15 March 1776. Walker to Lady Kames. NAS GD 24/1/496-503A./625-628.
12 April 1776. Lord Kames to Walker (Home: 1807): Appendix No. II, 66-68.
13 July 1776. Walker to Lord Kames. NAS GD24/1/571/157-163. Printed in (Home: 1807): Appendix No. II, 69-74.
29 July 1776. Lord Kames to Walker. EUL La.III.352/4 ff. 3-4.
12 April 1776. Lord Kames to Walker. NRAS 1073 Bundle 23 (private).
27 April 1776. Lord Kames to Walker. NRAS 1073 Bundle 23 (private).
10 August 1776. Walker to Lord Kames. NAS GD24/1/581/356-357.
Day? Mo? 1776. Walker to Lady Kames. NAS GD/24/1/502/8-11. (McKay: 1980; 3, 230)

1777
13 August 1777. James Tytler [Lord Woodhouselee] to Walker. EUL La.III.352/1 ff. 44-45.

1778
2 February 1778. Lord Kames to Walker. EUL La.III.352/4 ff. 5-6. (Shapin: 1974)
7 February 1778. Walker to William Cullen. GUL GB 247, MS Cullen 41, Thompson II 730.
19 February 1778. Sir John Pringle to Walker. Lost. Referred to in Walker's 28 February 1778 letter to Hailes (NLS MS 25303 ff. 5-6).
28 February 1778. Walker to Lord Hailes, David Dalrymple. NLS MS 25303 ff. 5-6.
7 March 1778. Walker to Lord Kames. NAS GD24/1/581/358-359.
26 June 1778. Walker to Lord Kames. NAS GD24/1/581/362-363.
?Day ?Month 1778. Walker to Lord Kames. NAS GD/24/1/581/. (MaKay: 1980; 3, 230)

1779
27 April 1779. Drummond Books to Walker. EUL La.III.352/1 end of the folder.
1779. Extract Act of Council in favor of the Revd. Dr. John Walker 1779. Approving him as the Keeper of the Museum &c of the University of the City. EUL La.III.352/1 end of the folder.
1779. Walker to T. Birch. BL Add. 4320 ff. 88.

1780
11 March 1780. Joseph Black to David Stewart. ECA McLeod's Bundles, 16 (Shelf 36), Bay C, MS 2. (Withers: 1993; 67)
21 March 1780. Walker to Provost and Edinburgh Town Council. McLeod's Bundle 16, Shelf 36, Bay C.
9 December 1780. Walker to Lady Kames. NAS GD 24/1/496-503A/631-632.

1781
30 October 1781. Prof. Patrick Wilson to Prof. J. Black. NAS Gen. 873/1/111-112.

1782
2 March 1782. Resolution of the Royal Society of Edinburgh to the King. EUL La.III.352/1 ff. 52-53

27 June 1782. Earl of Buchan to Walker. Presumed to exist. On the 'Principal Correspondence List' of EUL La.III.352.
8 July 1782. Presentation of the Earl of Lauderdale in favour of Doctor John Walker. EUL La.III.352/1 f. 54.
20 September 1782(?). The Parish of Colinton to Walker. The Parish of Collington's call to Walker. EUL La.III.352/1 f. 55.
18 October 1782. William Cullen to Walker. EUL La.III.352/4 ff. 7-8.

1783
3 November 1783. EUL La.III.352/1 ff. 56-57.

1784
24 January 1784. Walker to Robert Liston. British Ambassador in Madrid (NLS MS 5555 f.114-115). NLS MS 5540 f.34 and EUL SC MS EUL La.III.352/3. (Withers: 1991; 210).
5 February 1784. Samuel Grant to Walker. EUL La.III.352/4 ff. 9-10.
15 March 1784. Robert Liston to Andrew [Liston?]. Stating he will write to Dr. Walker on Andrew's behalf. NLS MS 5555 f. 86
1 April 1784. Robert Liston to Walker. NLS MS 5555 f. 92.
12 Aug 1784. Professor [Patrick?] Wilson to Walker. EUL La.III.352/4 ff. 11-12.
28 September 1784. Robert Liston to Andrew [Liston?]. NLS MS 5555 f. 120.
9 October 1784. Robert Liston to Mr. Galway. Contains a reference to 'Dr. Walker's List of Natural productions'. NLS MS 5555 f. 85.

1785
13 September 1785. John Robinson to Walker. EUL La.III.352/1 ff. 58-59.
6 October 1785. J. J. Brugmans [Professor in Groningen] to the Natural History Society of Edinburgh. EUL La.III.352/1 ff. 60-61.
8 October 1785. J. J. Brugmans to the Natural History Society of Edinburgh. EUL La.III.352/1 ff. 62-63.
16 November 1785. John Hope to David Skene. Ref. to Walker. AUL MS 38 ff.1-3. (Withers: 1993; 69)
Day? Month? 1785. Walker to Edinburgh Lord Provost, Magistrates, Town Council EUL SC MS EUL La.III.35215 and ECA, MacLeod's Bundles, 16 (shelf 36), Bay C, MS 3, ff.3-4. (Withers: 1991; 210).

1786
13 January 1786. James Ferguson to Walker. EUL La.III.352/4 ff. 15-16.
18 February 1786 [?]. Thomas Philipe to Walker. EUL La.III.352/1 ff. 68-69.
19 January 1786. A. Guyot to Walker. EUL La.III.352/1 ff. 66-67.
23 March 1786. Somerville [?] Wilson to Walker. EUL La.III.352/4 ff. 17-18.
2 August 1786. John Walker to Alexander Weir. EUL La.III 352/2 ff. 1-4.
13 November 1786. Gregory to Walker. EUL La.III.352/1 f. 70.
1786. John Walker to the Lords Commissioners of His Majesty's Treasury. EUL La.III. 252/2 ff. 5-6.
1786. John Walker to Edinburgh Town Council . EUL EUL La.III 352/2 ff. 7-8.

1787
[1]7 January 1787. M. [Archibald] Davidson to Walker. EUL La.III.352/1 ff. 71-72.
26 January 1787. John Robinson to Walker. EUL La.III.352/1 f. 73.
26 December 1787. Thomas Philipe to Walker. EUL La.III.352/1 ff. 74-75.
1787. EUL La.III.352/1 f. 76.

1788
19 January 1788. J. Murray to Walker. EUL La.III.352/1 ff. 79-80.
1 July 1788. Lord Chief Baron Robert Dundas to Walker. EUL La.III.352/1 ff. 81-82.
28 August 1788. Walker from [Carolies?] [Petrus?] [Thunberg?] to Walker. EUL La.III.352/1 ff. 83-84.
October 1788. [To or from Lord Hailes?] EUL La.III.352/1 ff. 87-88.
13 November 1788. List of Papers on general Physics belonging to the R.S.E, sent to Dr. Walker Nov. 13th 1788. EUL La.III.352/1 f. 89.

1 July 1788. Lord Chief Baron Robert Dundas to Walker. Presumed to exist. On the 'Principal Correspondence List' of EUL La.III.352.
1788. To the Lord of Balmoulou? EUL La.III.352/1 ff. 85-86.
1788? Lord Advocate to Walker. EUL La.III.352/1 f. 90.

1789
27 March 1789. J.W. to Walker. EUL La.III.352/1 ff. 91-92.
7 April 1789. Pultney to John Johnston. EUL La.III.352/4 ff. 21-22.
11 April 1789. John Johnston to Walker. EUL La.III.352/4 ff. 23-24.
28 May 1789. Lord Hales, David Dalrymple to Walker. EUL La.III.352/1 ff. 93-94.
13 August 1789. To Walker from Lord Bute. EUL La.III.352/4 ff.. 19-20.
31 August 1789. M. Garthshore to Walker. Presumed to exist. On the 'Principal Correspondence List' of EUL La.III.352.
2 December 1789. Fra[ncis?] Garden Lord Gardenston to Walker. Presumed to exist. On the 'Principal Correspondence List' of EUL La.III.352.
c1789-1790. A note concerning the Chair of Agriculture. EUL La.III.352/1 ff. 95-97.

1790
11 February 1790. Not of a collection submitted by R. E. Raspe. EUL La.III.352/1 ff. 98-100.
21 March 1790. Walker to ? About the Natural History Museum. ECA McLeod's Bundles, 16 (Shelf 36) Bay C, MS 2. (Withers: 1993; 68).
2 April 1790. [Philip?] Nelson to John Walker. EUL La.III.352/3 f.1.
26 April 1790. George Home-Drummond of Blair D[rummond] to Walker. Presumed to exist. On the 'Principal Correspondence List' of EUL La.III.352.
3 May 1790. David Wight to John Walker. EUL La.III.352/3 ff.7.
5 May 1790. Thomas Scott to John Walker. EUL La.III.352/3 f.12-13.
9 May 1790. John Buchanan of Cambusmore to Walker. EUL La.III.352/3 f.8-9.
12 May 1790. [David Thomson?] to [Walker?]. A petition to the General Assembly concerning the eradication of distempered sheep. EUL La.III.352/1 ff. 101-102.
27 May 1790. W. W. Grenville to Walker. EUL La.III.352/1 ff. 103-104.
5 June 1790. Wal[ter?] Scot of Shetland to John Walker.EUL La.III.352/1 ff. 105-108.
7 June 1790. William Matthews on behalf of the Agricultural Society of Bath to John Walker. EUL La.III.352/3 f.38-39
12 June 1790. Captian Charles Williamson to Walker. EUL La.III 352/3 f. 40-41. Withers (1988: f. 34)
1 July 1790. To Walker from Dr. Wright. EUL La.III.352/1 ff. 109.
7 July 1790. Mr. Drummond of Blair Drummond to Walker. EUL La.III.352/3 f.5-6.
17 July 1790. James Sands to Walker. EUL La.III.352/1 ff. 110-114.
1790. A. Bruce to Walker. EUL La.352/3 ff.43-54.

1791
25 February 1791. William Brodie to Walker. EUL La.352/3. f. 63-64.
7 February 1791. John Fell to Walker. EUL La.352/3 ff.55-58.
11 April 1791. George Henderson of Craigtoun [near Kirliston in Midlothian] to Walker. EUL La. 352/3 ff. 65-66. Withers (1988, f.34).
12 April 1791. William Creech to Walker. EUL La.III.352/1 f.115.
12 April 1791. William Brodie to Walker. EUL La.III.352/3 ff. 67-68.
5 May 1791. Lord Chief Baron Robert Dundas to Walker. EUL La.III.352/1 ff. 116-117.
25 May 1791. [Philip?] Nelson to Walker. EUL La.III.352/3 ff.83-84.
28 July 1791. William Thornton to Walker. EUL La.III.352/1 ff. 118-119.
August 1791. Rev. Jameson to Walker. EUL La.352/3 ff.69-80.
22 August 1791. John Fell to Walker. EUL La.III.352/3 ff.87-89.
21 October 1791. Lord Daer to Walker. EUL La.III.352/1 ff. 120-21.
27 October 1791. John Fell to Walker. EUL La.III.352/3 ff. 90-91.
1 November 1791. John Fell to Walker EUL La.III.352/3 ff. 92-92.

1792

7 January 1792. William Fair [Sec. of the Edin. Farmers Soc.] to Walker. Presumed to exist. On the 'Principal Correspondence List' of EUL La.III.352.
21 January 1792. Agricultural Society of Edinburgh to Walker. EUL La.III.352/1 ff. 122-123.
26 March 1792. George Home-Drummond to Walker. EUL La.III.352/1 Fols. 124-125.
c1792? Dr. George Hamilton to Walker. EUL La.III.352/1 ff. 126-127.
16 April 1792. [Dr.] A[lex] Carlisle to Walker. EUL La.III.352/1 ff. 128-129.
30 April 1792. Robert Fin[d?]lay [Glasgow Prof. of Divinity] to Walker. EUL La.III.352/1 ff. 130-131.
3 May 1792. John Anderson [of Glasgow College] to Walker. EUL La.III.352/1 ff. 132-134.
12 May 1792. Alex Gerard [Aberdeen Prof. of Divinity] to Walker. EUL La.III.352/1 ff. 135-136.
12 May 1792. Arch[ibald] Davidson [Principal of Glasgow College] to Walker. EUL La.III.352/1.
19 May 1792. Hugh Blair to Walker. EUL La.III.352/1 ff. 139-140.
27 August 1792. Walker to John Davidson, Writer to the Signet. EUL La.III.352/1 ff. 141-142.
17 September 1792. F. W. P. Fabricus to Walker. Presumed to exist. On the 'Principal Correspondence List' of EUL La.III.352.
17 November 1792. Sir Thomas Dundas to Charles Innes. EUL La.III.352/1 ff. 143-144.

1793

25 February 1793. George Home-Drummond of Blair Drummond to Walker. EUL La.III.352/1 ff. 145-146.
28 March 1793. George Dempsten [Demster of Dunnichen M.P.] to Dr. Robinson. EUL La.III.352/1 ff. 147-149.
30 March 1793. George Dempsten [Demster of Dunnichen M.P.] to Dr. Robinson. EUL La.III.352/1 f. 150.
24 April 1793. Jollie to [John Walker. EUL La.III.352/4 f. 25.
25 April 1793. James Nasmyth to Walker. EUL La.III.352/1 ff. 151-152.
3 May 1793. John Anderson [Glasgow Prof. Nat. Hist.] to Walker. Presumed to exist. On the 'Principal Correspondence List' of EUL La.III.352.
16 May 1793. George Home-Drummond of Blair Drummond to Walker. EUL La.III.352/1 ff. 153-154.
3 June 1793. John Robinson to the Royal Society of Edinburgh. EUL La.III.352/1 ff. 156-157.
31 August 1793. Dr. Garthshore to Walker. EUL La.III.352/1ff. 158-159.
4 September 1793. Maxwell Gordon to Walker. EUL La.III.352/1 ff. 160-161.
2 September 1793. John Walker to the Lord Advocate [no name given]. EUL La.III.352/2 f. 10. EUL EUL La.III 252/2 ff.11-13
30 September 1793. Capt. Veitch to Walker. EUL La.III.352/1 ff. 162-163.
3 December 1793. Jollie to Walker. EUL La.III.352/1 ff. 164-165.
1793. Bill from Murray and Cochran. EUL La.III.352/1 f. 155.

1794

7 January 1794. A. Guyot to Walker. EUL La.III.352/1 ff. 166-167.
4 July 1794. Walker to Robert Liston. NLS MS 5574 f.151-152.
17 October 1794. Wilson to Walker. EUL La.III.352/1 f. 168.
4 December 1794. Maxwell to Walker. EUL La.III.352/1 ff. 169-170.

1798

4 September 1798.[Dr. J.?] Armstrong to Walker. EUL La.III.352/4 ff. 26-27.
Walker to Joseph Black. EUL Gen.874/IV/51-52.

179?

14 September 179?. A Measurement of the land of Collington by W. Nicols. EUL La.III.352/1 f. 173.

1801

1801. Walker to W. Wright. BL 32439 f. 26.

1800

7 July 1800. Printed request from John Playfair to attend the General Meeting of the Royal Society. EUL La.III.352/1 ff. 174-175.

8 July 1800. Account of Money Paid out by Dr. Walker for the Museum. EUL La.III.352/1 ff. 176-177.
c.1800. Dr. Smith [?] to Braugham [?]. EUL La.III.352/4 f. 31.

1802
16 March 1802. Board of Agriculture to Walker. EUL La.III.352/1 ff.178-179.

1803
1803. Anonymous letter on peat. EUL La.III.352/1 ff. 180-181.
5 March 1803. Walker to Prof. Jameson. EUL Gen. 1999/1 f.154.
9 April 1803? Letter by Walker regarding an MS. EUL La.III.352/1 ff. 182-183.

1804
1804. Excerpt from Walker's Settlement. EUL La.III.352/1 ff. 184-185.

Undated Letters:

11 April 17??. George Stuart to Walker. EUL La.III.352/4 ff. 28-29.
Saturday Morning, no date. Thomas Beddoes to Walker. EUL La.III.352/4 ff. 30-31.
Undated. Henry Home [Lord Kames] to Walker. EUL La.III.352/4 ff. 32-34.
Undated. Lord Kames to [?]. EUL La.III.352/4 ff. 35-36.
[Before 1786?]. A report on the status of the natural history museum. EUL La.III.352/5 f. 1.
[No Date]. To Lord Kames from [John Walker?]. EUL La.III.352/5 f. 2.
[No Date]. Ignatius [Maria Ruiz] Luzariaga to the President of the Natural History Society. EUL La.III.352/5 ff. 3-4.
Walker to Lady Kames. NAS GD/24/1/502/12-13. (McKay: 1980; 4, 230)
Walker to Lord Kames. NAS CH1/1/55. (McKay: 1980; 4, 230)
'A correspondent of the Duke of Newcastle'. NLS MS 98 ff. 39-40. (McKay: 1980; 9, 231)
1764? Walker to Lord Kames.. NAS GD 24/1/571/5. EUL La.III 352/1. (McKay: 1980; 9, 231).

APPENDIX V

The University of Edinburgh natural history class lists 1782-1800[1]

Geographical Origins

Of the 667 names on Walker's class lists, about 150 did not list their home city or country. Of the others, 286 (50%) were Scottish and 101 (20%) were English. The rest of the students came from the other parts of the United Kingdom, United States, Europe, the British Colonies and India. From across the Irish Sea, students came from Ireland (27) and the Isle of Man (2). Several students were citizens of the United States of America. The states represented in this group are Massachusetts (1), Delaware (2), Kentucky (1), Maryland (5), New York (7), Pennsylvania (2), South Carolina (8) and Virginia (9). These numbers demonstrate that an equal amount of students came from both the commercial North and agricultural South. A few of the European students came from countries or city-states that bordered the Baltic: Prussia (1), Danzig (1), Hamburg (1), Russia (2) and Sweden (2). Others came from Switzerland (6) and from the western tip Europe: Flanders (2), France (2), Portugal (2) and Spain (1). One student came from Brazil, a colony of Portugal. Over the twenty years covered by the lists, a steady stream of students also came from British territories. The Caribbean had the highest number, with Jamaica being its largest contributor (12). Other islands represented include Antigua (3), the Bahamas (1), Barbados (2), Bermuda (1), St. Christopher (1) and St. Kitts (1). One student came from East Florida and another came from Nova Scotia (both British colonies at the time). Finally, there were 4 students from Britain's Indian colonies.

On a more local scale, Walker's students came from just about every shire of mainland Scotland, many of them being from the south and the east. Geographically speaking, the University of Glasgow was more convenient for those living in the north-west Lowlands and the University of Aberdeen was closer for students who came from the north-east. This being the case, Walker still taught several students from the Shetland Islands, the Orkney Islands and the Hebrides. Of the 151 students who did not list their home city, their surnames indicate that the majority of them were probably from Scotland or of Scottish origin. Regardless of their origin, it was sometimes the case that a group of students would come from the same area at about the same time. Most of the time these groups were composed of either brothers or cousins. A good example of this practice can be seen with the Douglas family of Kilhead. The first recorded Douglas was Archibald, who attended in 1795. His three brothers then followed him: Sir Charles (1796), Henry Alexander (1799) and John (1799). In addition to these familial connections, Walker's list is also geographically interesting because it often states where the students lived. Rose Street and Prince's Street seem to have been a popular place to live. South Richmond Street, Queen's Street and Nicholson's Street are also mentioned. In addition to their residence, a few entries contain the name of the person who was responsible for paying the student's fees. In several of these cases, this financial chaperon was a "Dr. Wright", who is most probably Dr. William Wright. He not only administered fees but also referred students to Walker's course.

Note on the Arrangement

As this list contains well over 650 names, its biographical potential is immense. I have only included information on students who are actually noted on the original lists themselves. Such an approach means that students who would

[1] This introduction and the following class lists will be published in the vol. 30 of *Archives of Natural History* (forthcoming, 2003). I wish to thank D. M. Knight and E. Charles Nelson and an anonymous reviewer from *ANH* for their helpful comments.

eventually become famous or influential (Mungo Park or James Edward Smith for example) are treated as they would have been when Walker was originally taking attendance. Since many of the students had a significant impact upon the field of botany, Ray Desmond's *Dictionary of British and Irish Botanists and Horticulturalists* contains many of their names and may be consulted for biographical information and a more detailed account of their works. Additionally, names of some of the Irish students, Thomas Addis Emmett and Francis Barker for example, can be found in Burtchaell and Sadleir's *Alumni Dublinenses*. Sometimes the information given by Walker is very vague and I have had to supply some extra information in a footnote. I have also taken care not to modernise surnames that might now be spelled differently. If the name is spelled inconsistently on different documents, I have inserted the additional letters in brackets. A quick look at the list will also reveal that it seems several students have been listed twice. This occurs in places where I could not be completely sure that the two names did not represent different students. I followed this practice because there were often people who had the same name (the proverbial 'James Kerr' for example) and because some students changed their degree. Like the personal names, I have also tried to leave local place names intact. However, for clarity, I did change a few larger place names like Swisserland (Switzerland), Zetland (Shetland) and Danzick (Danzig) to their modern spelling. When listing their geographical origin, the students (or sometimes Walker) did not follow the same pattern. Most British students only listed their home county, while foreign students listed their home city and country. I have tried to preserve this format.

Note on the fees:

1 Guinea = £1.1.0	Crown = 5s	Pound/Libra (Gold)
£1 = 20/- or 20s (shillings)	Halfpenny (Hape-nee) = ½ d	Shillings/Sestertiae (Silver)
1/- = 12d (pence)	Farthing = ¼ d	Pence/Denarii (Copper)

The University of Edinburgh Natural History Class Lists 1782-1800

M.S. – Medical Student (Medical Faculty) Ph.S – Philosophy Student (Arts Faculty) ¶ Quaker
Th.S. – Theology Student (Divinity Faculty) L.L.D. – Law Student (Law Faculty) + Second Course
N.S. – Navy Surgeon W.S. – Writer to the Signet
M.D. – Medical Doctor A.M./M.A. – Master of Arts
Esq. Esquire NHS – Natural History Society

Name	Degree/ Vocation	Year	NHS Essay(s)	Origin/Walker's Notes
Adams, John	M.S.	1795		Richmond, Virginia
Ainslee, Daniel	Merchant	1796		Edinburgh
Ainslee, Daniel	M.S.	1800		Edinburgh
Alexander, Robert	M.S.	1795		Maryland
Allen, Robert	M.S.	1795/96		Edinburgh. Son to Mr Allan, Trustees Office.
Allen, James	Ph.S.	1797		Edinburgh. Brother of John Lee Allen.
Allen, John Lee	Ph.S.	1797		Edinburgh
Alves, Henry Scott	Ph.S.	1793		Dalkeith
Alvey, Samuel	M.S.	1786		London
Anderson, Charles	M.S.	1792		Leith. Son to Mr. Anderson, Surgeon.
Anderson, Charles	Ph.S.	1793		Leith
Anderson, James	M.S.	1792		Edinburgh
Armstrong, James	M.S.	1789		Belfast
Bachmetieve, George[2]		1784	*	Russia
Baillie, James Hope	Ph.S.	1798		Son to William Baillie, Knight Lord Polkemmet (Judge Advocate who died in 1816).
Baird, [?]	Preacher	1786		
Baird, James	Preacher	1793		
Baker, John Pool	Ph.S.	1793	*	Jamaica
Balfour, John	M.S.	1795		Rosshire
Ballingall, David	M.S.	1793		Fifeshire
Balmain, John	M.S.	1799		Edinburgh
Barker, Francis	M.S.	1794		Waterford, Ireland
Barclay, John		1795		Perthshire
Barker, Henry	M.S.	1786		Beverley, Yorkshire
Barnaby, George Freeman	Ph.S.	1799		Leicestershire
Barnett, John	M.S.	1793		Staffordshire
Barnewall, Richard	Ph.S.	1800		Edinburgh
Baron, Alexander		1786		Linlithgow
Baron, Alexander	Ph.S.	1786		Linlithgowshire
Baron, Patrick	Ph.S.	1786		Linlithgowshire
Bartlet, John	Apothecary	1792		Edinburgh
Bathie, Francis	M.S.	1789		Edinburgh
Beddoes, Thomas	Student	1784/85+	*	Pembroke College, Oxford
Beetham, Campbell	M.S.	1784		Isle of Man
Bell, Alexander	M.S.	1794		Fifeshire
Bell, George	M.S.	1795		Edinburgh.Son of Mr. Bell, Edinburgh Surgeon.
Bell, James	M.S.	1792	*	Roxburghshire
Berry, Andrew	M.S.	1784		
Bevan, Robert	M.S.	1800		Glamorganshire
Binning, William	Esq./Advocate	1782		
Bishop, Edward	Surgeon	1789		County Cork, Ireland. Surgeon, 35th Regiment.

[2] PNHS, Vol. IV (EUL Da 67) states that he was from Moscow. f. 45.

Blake, Malachi	M.S.	1791	*	Somersetshire
Blount, William	M.S.	1786		London
Boswell, William	Ph.S.	1794		Edinburgh
Bott, John Boswell	M.S.	1799		Petersburg, Virginia
Bower, Patrick		1782		England
Bradley, Thomas[q]	M.S.	1789	*	[Possibly London]
Braidwood, William	Merchant	1799		Edinburgh
Broun, Richards	M.S.	1793		Stamford
Brown, Alexander	Surgeon	1793		Dumfries
Brown, Andrew	Chaplain	1782		Chaplain, 21st Regiment.
Brown, Andrew		1795		Ayrshire
Brown, Charles	M.S.	1794		Jamaica
Brown, Francis Frye	M.S.	1793		Antigua
Brown, James	Surgeon	1799		Aberdeenshire. Surgeon, Gordon Fencibles.
Brown, Robert	M.S.	1792		Edinburgh
Brown, Robert	Ph.S.	1800		
Brown, Thomas	L.L.S.	1795		Creetown, Galloway
Brown, Thomas	M.S.	1795		Lanarckshire
Brown, William Cullen	Ph.S.	1793		Edinburgh
Browning, Thomas	Ph.S.	1794		London
Bruce, Archibald	M.S.	1800		New York
Bruce, James		1782/83		Edinburgh
Bruce Thomas [Jr.]	Ph.S.	1794		Kinross
Brunton, [Alexander?]	Tutor	1795		Tutor to James Maitland (1784-1860), Viscount Maitland [the future Earl of Lauderdale].
Bryce, James	Th.S.	1791		Edinburgh
Buchan, James	Ph.S.	1786		Edinburgh
Buchan, Lord		1782		David Steuart Erskine, Earl of Buchan
Buchanan [Francis?][3]	M.D.	1783		
Buchanan, Robert	M.S.	1795		Kirkcudbright
Bulkely, Michael	M.S.	1793		Country Cork, Ireland
Bull, Francis	M.S.	1792		Bristol
Bulmass, Thomas	Ph.S.	1800		Newcastle
Burgess, James	Ph.S.	1782		Dumfrieshire
Burgess, James	M.S.	1783		
Burnet, George	M.S.	1800		Somersetshire
Burrel, William	Fossilist	1792		Edinburgh
Burton, Robert	Th.S.	1797		Edinburgh
Cadell, Archibald	Ph.S.	1791		Edinburgh
Cadell, George	Merchant	1798		Edinburgh
Cadell, William A.		1792+		
Caddel, William	Ph.S.	1792		Stirlingshire
Caddell, William Archibald	L.L.S.	1798+		
Campbell, Major General		1792		Boquham
Campbell, Author Cuthbert	Ph.S.	1800		Edinburgh
Campbell, Dugald	Ph.S.	1798		Duddingstone. Son to Colonel Campbell.
Campbell, George	Ph.S.	1798		Duddingstone. Brother of William Campbell
Campbell, Hay	Ph.S.	1799		Son to the Receiver General [of Duddingston?].
Cambell, James	Ph.S.	1794		Duddingstone. Son to Colonel Campbell.
Campbell, John	W.S.	1792		
Campbell, John	M.S.	1800		Lorn, Ayrshire
Campbell, Peter	Ph.S.	1799		Edinburgh
Campbell, William	Ph.S.	1798		Fairfield
Campbell, William Coote	Ph.S.	1800		Duddingstone. Son to Colonel Campbell.

[3] A Francis Buchanan, A.M., gave a paper in the PNHS, Vol. I. in 1782, f 32-37.

Can, George, Esq.	Esq.	1782		Secretary to the Board of Excise.
Cannan, David	Ph.S.	1800		Edinburgh. Recommend by Mr. Dallas [Pallas?].
Cappe, Robert	M.S.	1795		York
Carpenter, Joseph Mason	M.S.	1792	*	Wiltshire
Carro, John de	M.S.			Geneva
Chaer, Richard Blacket de	Student	1782		London
Chalmers, Alexander		1786		Culross
Checkers, [?]	M.S.	1800		Barbadoes
Christian, Alexander		1794		Edinburgh
Christie, Thomas	L.L.S.	1792		Fifeshire
Christy, Mathew	M.S.	1798		Primrose, Midlothian
Clark, Alexander Kennedy	Ph.S.	1798		Dumfries
Clark, John Franklin	M.S.	1784		Devonshire
Clark, William	Ph.S.	1794		Edinburgh
Clark, William	M.S.	1800		Moffat, Shotts Parish
Clarke, Joseph	M.S.	1795		London
Cleghorn, Thomas	M.S.	1793		Ireland
Clerk, James	M.S./Clerk	1786		Edinburgh. Clerk to the Royal Infirmary.
Cleverly, Samuel	M.S.	1794		Gravesend
Clidsdale, Archibald	M.S.	1793		Edinburgh
Cochrane, Hon. Andrew		1783		
Cockburn, Henry	Ph.S.	1798		Son of Baron Cockburn.
Cockburn, Patrick	M.S.	1791		
Colquhoun, Capt. James	Soldier	1796		Luss. Attached to the 97th Regiment.
Colquhoun, John		1795		Renfrewshire
Colquhoun, Peter	Ph.S.	1796		Son to Sir James Colquhoun.
Constancio, Francisco Solano	M.S.	1794		Portugal
Cooper, John	M.S.	1793		Bedford
Cooper, Thomas Beale	M.S.	1792		Warwickshire
Corbet, Peter	L.L.S.	1797		Edinburgh
Corrie, Thomas	Ph.S.	1793		London
Corrie, William	Ph.S.	1797		Liverpool
Cox, Joseph Mason	M.S.	1786	*	Bristol
Coxon, Ralph	Ph.S.	1796		Alnwick, Northumberland
Craigie, Laurence [Jr.]	Ph.S.	1799		Glendorck, Perthshire
Cramond, Hercules	M.S.	1784		London
Crawford, John Innes	Ph.S.	1793		Jamaica
Creech, William	Bookseller	1796		
Cririe, James	School Master	1798		A.M. Master of the [Edinburgh?] High School.
Cullen, Archibald	M.D.	1782		
Cullen, Henry	M.D.	1782		
Cullen, Robert	Advocate			
Culton, John	Ph.S.	1794		Dumfries
Cuming, George		1792		
Cuming, George	Ph.S.	1792		Edinburgh
Cun[n]ingham, Charles	Th.S.	1794		Edinburgh
Cuningham, James	Writer	1782	*	Edinburgh
Cuningham, James	Ph.S.	1791		
Cuningham, Thomas	Ph.S.	1789		Edinburgh
Curry, James	M.S.	1784		Antrim, Ireland
Cusack, John William	M.S.			Dublin
Cust, The Honourable John		1795		Lincolnshire
Daer, Rt. Honourable Lord		1782		Son to Lord Selkirk of the Doulgas family.
Dalrymple, Charles	Ph.S.	1793		Edinburgh. Son of Lord Westhall.
Dalrymple, Hugh Jr.		1782		Westhall
Darwin, Robert Waring	M.S.	1784	*	
Davidson, James	M.S.	1796		Linlithgowshire

Davidson, Robert	M.S.	1794		Edinburgh & Ravelrig
Davidson, Thomas	Ph.S.	1796		Son to Thomas Davidson, D.D. (1747-1827).
Davis, John Ford	M.S.	1795		Bradford, Wiltshire
Dempster, [?]	Apothecary	1796		
Dewar, Daniel	Ph.S.	1792		Edinburgh
Dewar, Henry	Ph.S.	1797		Fifeshire
Dickson, Archibald	Ph.S.	1795		Hassindeanburn, Teviotdale
Don, Alexander	Ph.S.	1797		Eldest son of Sir Alexander Don of Newton.
Donovan, John Middleton	M.S.	1800		
Doorman, Francis Caspar	Ph.S.	1796		Hamburg
Douglas, Alexander	Th.S.	1797		
Douglas, Archibald	Ph.S.	1795		Brother of Sir Charles of Kilhead.
Douglas, Sir Charles, Bart.	Ph.S.	1796		Kilhead
Douglas, Henry Alexander	Ph.S.	1799		Brother of Sir Charles of Kilhead.
Douglas, John	Ph.S.	1799		Second brother of Sir Charles of Kilhead.
Douglas, John	Writer	1791		Edinburgh. Lecture Notes Housed in EUL.
Douglas, William	Ph.S.	1800		London
Douglas, William Robert	Ph.S.	1799		Fourth brother of Sir Charles of Kilhead.
Dou[re?], [?]	Ph.S.	1792		Edinburgh
Duff, Adam				
Duff, Adam	Ph.S.	1792		
Dunbar, Archibald	L.L.S.	1792		Murrayshire
Duncan, Andrew	M.S.	1792		
Duncan, John	M.S.	1784		
Duncan, John	M.S.	1794		Edinburgh
Duncan, Thomas	M.S.	1794		Dunbar
Duncombe, Kingsby	Ph.S.	1798		Helmsley , York
Dunning, Richard Barré		1797-00		[Baron Ashburton (1782-1823). Paid £5-2-0, compared to the £3-3-0 of Henry Richard Greville, Lord Brooke.]
Dygheas, Louïs		1792		Ypres, Flanders
Edgar, Alexander	M.S.	1792		Hamilton, Clydesdale
Elcock, Nicholas		1785		
Elliot, William		1782		
Elliston, [?]		1783+		
Emmet, Thomas Addis	Ph.S.	1800	*	
Erskine, Henry [Jr.]	Ph.S.	1799		Son to the Honourable Henry Erskine.
Erskine, Thomas	Ph.S.	1800		Son to Mr. Erskine of Marr.
Erskine, Henry David	Ph.S.	1794		Marr
Erskine, John James	M.S.	1789		Jamaica
Erskine, Patrick	M.S.	1794		Edinburgh
Falconer, Shickle	M.S.	1785		Leverpool
Fergusson, Henry		1792		
Ferguson, Hugh	M.S.	1793		Dublin
Ferguson, Joseph	Ph.S.	1789		Edinburgh. Son of Professor Adam Ferguson.
Fergusson, Henry	Ph.S.			Craigdarroch, Dumfrieshire
Fergusson, James [Jr.]	Ph.S.	1786		Craigdarroch, Dumfrieshire
Fitt, Samuel	M.S.	1784	*	Bermuda
Findlaterre, James	M.S.	1798		Dumfrieshire
Fisher, John	M.S.	1800		[Duddingston?]
Fitzgerald, John	M.S.	1799		Virginia
Forbes, Duncan	Preacher	1796		Edinburgh
Forbes, Duncan [Jr.]	Ph.S.	1798		Culloden
Forbes, John	Ph.S.	1798		Son of Sir William Forbes
Forrest, Abraham	Preacher	1789		

Forrest, James	Ph.S.	1800		Comieston
Forrest, James	Esq.	1786		Comiston
Forsyth, James	Ph.S.	1798		Halifax, Nova Scotia
Foster, John	M.S.	1793	*	Kingston upon Hull,Yorkshire
Foster, Thomas	Ph.S.	1795		Dorsetshire
Fowler, Richard	M.S.	1786		London
Fraser, John	Ph.S.	1798		Son to Mr. Fraser, Sheriff of Invernesshire.
Fraser, Luke	School Master	1794		A. M. Master in the [Edinburgh?] High School.
Fraser, Thomas	Writer	1789		Edinburgh
Frazer, Archibald		1793		Lovat
French, [?]		1783		
Fryer, James	M.S.	1789		
Fyfe, [?]	Surgeon	1800		Recommended by Mr. Creech.
Gahagan, John	M.S.	1789	*	Ballinasloe, Ireland
Gahagan, Joseph	M.S.	1789	*	Dublin
Gardner, James	Merchant	1799		Edinburgh
Gallaway, Henry	M.S.	1785		Stirlingshire
Galley, [?]	M.S.	1784		Leverpool
Garnock, Henry	Preacher	1796		A.M.
Gheus, M. Louis de	[Diplomat]	1792		Imperial Service, [from?]Ypres in Flanders
Gibb, James		1800		Renfrewshire
Giles, William	Ph.S.	1794		Edinburgh
Gillespie, David	L.L.S.	1796		Fifeshire
Gillespie, Robert	Ph.S.	1784		Anandale
Gillespie, William	Ph.S.	1797		Galloway
Gimbernat, Signor Charles	Ph.S.	1792		Barcelona, Spain
Girdlestone, Thomas	M.S.	1786		Norfolk
Glasgow, Rt. Hon. Earl of		1782		Glasgow
Glendenning, Robert	Th.S.	1783		
Glendenning, Robert	Ph.S.	1784		Anandale
Goodsich, Edward	Ph.S.	1783		Virginia
Gordon, Charles	Ph.S.	1800		Edinburgh
Gourlay, Robert	Ph.S.	1796		Craigrothie, Fifeshire
Graham, Charles Alex. [Jr.]	M.S.	1792		
Graham, James [Jr.]	Ph.S.	1800		Kenross
Graham, John	Ph.S.	1800		
Graham, John	Ph.S.	1796		Edinburgh
Grant, J. R.		1792		Rothiemurchus
Grant, James	Ph.S.	1791		Glenmoriston
Grant, John	Ph.S.	1791		Edinburgh
Grant, John	Ph.S.	1793		Edinburgh
Grant John Charles	M.S.	1792		Edinburgh
Grant, John Peter	Ph.S.	1792		Rothiemurchus
Grant, Johnson	Ph.S.	1792		Edinburgh
Greenhill, Charles	Ph.S.	1796		Dundee
Greenlow, James	M.S.	1796		Virginia
Grey, Henry	Ph.S.	1795		Edinburgh
Greville, Henry Richard		1797		Paid £5-2-0, compared to the normal £3-3-0 [Earl Brooke of Warwick Castle, son to George Greville, Earl of Warwick]
Grimston, Henry Esq.		1785		Yorkshire
Guyot , Abraham		1784/85		Neuchâtel, Swizterland
Hahnbaum, George Frederick		1791		Charleston, South Carolina
Haig, John		1784		Edinburgh
Haig, Robert		1783		
Hall, Sir James		1782		Dunglass

Hall, James	Preacher	1789		
Hall, James	M.S.	1792		
Hall, Robert	N.S.	1782		Jedburgh
Hall, William	Ph.S.	1794		Berwick
Hamersley, William	M.S.	1786		New York
Hamilton, Archibald	Ph.S.	1792		Sundrum, Ayrshire
Hamilton, John Hay	Ph.S.	1799		Son of Prof. Alexander Hamilton [Medical Faculty]
Hamilton-Pryce, Dunbar				
Hardy, Thomas	M.S.	1782	*	England
James Hare	M.S.	1796		Ayrshire
Harris, George	M.S.	1785		Pembrokeshire
Hastie, James	M.S.	1792		London
Hatts, Robert	M.S.	1791		Colchester, Essex
Hay, Andrew Leith	Ph.S.	1800		
Heald, Richard	M.S.	1796		Horncastle, Lincolshire
Heath, John	M.S.	1786	*	Staffordshire
Helsham, Henry	M.S.	1789		Norfolk
Henderson, Thomas	Ph.S.	1794		Fifeshire
Henderson, William	M.S./N.S.	1784		
Henry, Rev. Dr. [?]		1782		
Henry, Hugh	Ph.S.	1794		Dublin
Heron, Robert	Preacher	1789	*	
Hibbard, Rowland	M.S.	1800		
Hill, Henry		1782		
Hill, James		1795		Dumfries
Hill, John		1797		Son to Principal Hill.
Hilton, John	B.A. (Cantab)	1782		
Hind, Samuel	M.S.	1785		Barbadoes
Hodges, John	M.S.	1799		Norfolk, Virginia
Hog, [?]		1783		
Home, David	Ph.S.	1796		Son of Dr. Home.
Home, Francis[4]		1795		Son of Dr. Home.
Hooper, Joseph	M.S.	1799		Bristol
Hope, Hugh	Ph.S.	1798		Son of Sir Archibald Hope.
Hope, James	Ph.S.	1786		Edinburgh
Hope, John	Ph.S.	1798		Son of Sir Archibald Hope.
Hope, Thomas	M.S.	1782		
Hope, Thomas Charles	M.S.	1784		Son to John Hope, Professor of Botany [Medical Faculty]. Lecture notes in EUL.
Horner, Thomas [Jr.]		1782		Mills-Park, Somersetshire
Houston, Ludovic	Ph.S.	1800		Son of Houston of Johnston Renfrewshire. Brother to William Houston.
Howard, Crane	M.S.	1784		Leverpool
Howard, John [Jr.]		1782		Befordshire
Huger, Francis Kinloch		1791		Charleston, South Carolina
Hughes, James	Th.S.	1785		[Constorphine?]
Hunt, J.	Ph.S.	1793		New Providence, Bahamas
Hunter, Rev. Dr. Andrew	Professor	1798		EU Prof. of Div. (1779-1809)
Hunter, George	M.S.	1792		York
Hunter, James	Preacher	1784		
Hunter, Robert, Esq.		1797		Lunna, Shetland
Hunter-Blair, Forbes	Ph.S.	1797		Edinburgh. Son of Sir James Hunter-Blair.
Hunter-Blair, Thomas	Ph.S.	1798		Edinburgh. Son of Sir James Hunter-Blair.

[4] The father of David and Francis Home is most probably Dr. James Home (1760-1844), who was appointed to the University of Edinburgh's medical faculty in 1798.

Hurst, Thomas	M.S.	1782	Portsmouth, Hampshire
Indefonço, Signor [Aboeu?]	Ph.S.	1792	Brazil
Ingram, James	Ph.S.	1784	London
Innes, William	L.L.S.	1796	Moray
Ireland, John	Ph.S.	1792	Perthshire
Irvine, David	Ph.S.	1799	Langholm. Tutor to Hay Campbell.
Irving, John Robert	Esq.	1791	Bonshaw
Irving, Ralph	M.S.	1784	
Jack, William	Professor	1794	A.M., M.D. King's College, Aberdeen.
Jackson, James	Preacher	1795	Edinburgh
Jackson, William	M.S.	1785/86+	Boston, New England
James, Thomas	M.S.	1792	Pennsylvania
Jameson, Robert	M.S.	1792/93+ *	Leith
Jameson, William	Ph.S.	1785 *	Edinburgh
Jardin, Alexander [Jr.]	Esq.	1793	Applegirth
Jeffray, James	M.S.	1783/84 *	
Jeffreys, Thomas	M.S.	1796	Shropshire
Jennings, Michael Alex.	M.S.	1795	Jamaica
Johnson, [?]		1800	Edinburgh. Mate to an Indiaman.
Johnson, T.[5]		1789	
Johnson, Robert	Ph.S.	1793	Newcastle
Jones, Richard		1782	Isle of Wight
Junor, William		1782	
Keantish, William Gordon	M.S.	1789	London
Keith, [?]	Clerk	1784	Clerk to the Royal Infirmary.
Kennedy, Robert	Ph.S.	1800	Eldest son of Mr. Kennedy of Underwood.
Ker, [?]	Preacher	1786	
Ker, Andrew	M.D.	1792	Dublin
Kerr, James	Ph.S.	1786	Leith
Kerr, James	Ph.S.	1791	
Kerr, James S.	M.S.	1792	Jamaica
Kerr, Robert	Surgeon	1789	Edinburgh
Kerr Robert	Ph.S.	1794	Bengal
Kerr, Thomas Cairns	Writer	1795	Edinburgh
Kerr, William[6]		1782	[Marquess of Lothian], Earl of Ancrum
King, Thomas	M.S.	1794	Jamaica
Kingston, John	Ph.S.	1798	Edinburgh
Kinnaird, Thomas	Druggist	1783 *	Edinburgh
Kirkaldie, George	M.S.	1784 *	
Kissam, Richard S.		1786	New York
Laird, James	M.S.	1800	Jamaica
Lane, John	M.S.	1786	Cork
Latta, James	Surgeon	1782	Edinburgh
Latham, John	M.S.	1799	Cork, Ireland
Latherdale, Robert	M.S.	1793	Kirkcudbright
Laurence, Richard	M.S.	1785	New York
Laurie, [?]	Preacher	1784	
Laurie, Alexander		1800	Galloway
Laurie, [?]		1800	Langholm
Law, John	Esq.	1783	
Lee, John	Ph.S.	1798	Stow
Lehre, William	M.S.	1789+	Charlestown, South Carolina
Leigh, John	M.S.	1785	Virginia
Leith, Theodore Forbes	L.L.S.	1796	Kent
Leslie, Andrew	Ph.S.	1792	Edinburgh

[5] Not on the class lists. His name appears on a set of lecture notes taken *circa* 1789. See T. Johnson, Notes and Lectures on Natural History, Vols. 1-4, EUL, Gen 50-53.
[6] Also spelled Earl of Ancram. Attended 4 March 1782. His name is also on the list for the Second Session, Nov. 1782, for a second course.

Lessert, Benjamin de	Ph.S.	1784/85+		Paris
Lessert, Stephen, de	Ph.S.	1784/85+		Paris
Leven, John	L.L.S.	1797		Edinburgh
Leyden, John	Th.S./A.M.	1797+		Roxburgshire. Tutor to William and George Campbell of Fairfield.
Lindoe, Robert	M.S.¶	1789	*	London
Linlithgow, Patrick		1786		
Loch, James	Ph.S.	1798		Edinburgh
Lochhead, William	M.S.	1785+	*	Renfrewhshire
Lockhart, Charles	Ph.S.	1796		Rosshire
Lockhart, William	Writer	1783	*	Edinburgh
Lockheart, Samuel	M.S.	1789		Galloway
Lorimer, [?]	Preacher	1792		Dumfriesshire
Lothian, Edward	W.S.	1796		
Lowe, Robert	M.S.	1789		Brechire, Forfarshire
Loy, John	M.S.	1799		Whitby, Yorkshire
Luxmoore, Henry[7]	[M.D.]	1786	*	Oakhampton, Devonshire
Lynch, Martin	M.S.	1789		Dublin
Macarthy, Dennis	M.S.	1798		Cork
Macay, Samuel	M.S.	1784		Antrim
MacBeth, Patrick	Preacher	1791		
Macormick, Joseph	Ph.S.	1792		St. Andrews
Maculloch, John	M.S.	1792		Bretagne, France
MacDonald, Dugald	M.S.	1786		Jamaica
MacDonald, James	M.S.	1783		
MacDonald, James	M.S.	1800		
MacDonald, William	Ph.S.	1800		Powder Hall
MacDonnel, [?]	M.D.	1785		Ireland
MacEwen, James	M.S.	1786		Stranrawer
McFarlane, Frederick	Th.S.	1784		
Mackay, Daniel	Soldier	1783		Ensign in the Dutch Service.
MacGillivray, John	Ph.S.	1799		Invernesshire
Macharty, Alexander	Ph.S.	1793		Renfrewshire
Mackenzie, Alexander Muir		1782		Delvin
Mackenzie, Colin	Ph.S.	1799		Edinburgh
Mackenzie, Kenneth	Ph.S.	1794		Edinburgh
Mackintosh, Richard Duncan	M.S.	1799		London
Mackintosh, William	Ph.S.	1797		Invernesshire
Macknight, Thomas	Minister	1797		Leith
MacLachan, Allan	M.S.	1789		Isle of Mull
Maclean, William	Ph.S.	1800		Edinburgh
McLeod, Robert	Esq.	1782		Catbell
MacLiesh, David	M.S.	1789		Fifeshire
MacNab, John		1789		Perthshire
Mcnamara, B. S.	M.S.	1798		Ireland
Mcnight, Samuel	Preacher	1784		
Maconochie, Alex. [Jr.]	Ph.S.	1793		Meadow Bank
Macredie, Archibald [Jr.]	Ph.S.	1793		Preston, Ayrshire
Macredie, Thomas	M.S.	1799		Preston, Ayrshire
Macredy, William	Esq.	1782		Preston, Ayrshire
Mcrobert, Rev.	Minister	1782		Shetland
Malcolm, James	N.S.	1784		
Manners Alexander	Esq.	1792		
Maxton, James		1794		
Maxwell, Francis		1794		Glasgow
Maxwell, James	M.S.	1786		South Carolina
Maxwell, James Alexander	Ph.S.	1800		Edinburgh
Maxwell, John	M.S.	1782		Dundee

[7] Listed as "Dr. Henry Luxmore of Devonshire" in PNHS, vol. VII, EUL Da 67 f. 47.

Maxwell, John	Ph.S.	1800		Eldest son of [a] Maxwell in Barncleugh.
Maxwell, William	M.S.	1786		Galloway
Menzies, John	M.S.	1795		Leverpool
Menzies, Neil	Ph.S.	1800		Edinburgh
Menzies, Neil	Ph.S.	1796		Edinburgh
Mercer, Thomas	Writer	1782	*	Edinburgh
Mitchell, Robert Cary	Ph.S.	1784	*	Virginia
Mickie, George	M.S.	1797		Edinburgh
Mickleim, Godfried	Ph.S.	1789		Danzig
Millar, James	Preacher	1795		Ayrshire
Miller, [?]	M.D.	1798		
Miller, Alexander	L.L.S.	1794		Ayrshire
Miller, Daniel	Missionary	1800		
Miller, Thomas Hamilton	Ph.S.	1794		
Miller, Thomas H.	Ph.S.	1792		Oalswinton
Miller, [William?]	M.S.	1794		Jamaica
Milligan, James	Ph.S.	1789		
Mitchell, [?]		1785		Mr. Mitchell's Nephew.
Mitchell, James	Preacher	1800		
Mitchell, Samuel Latham	M.S.	1786		New York
Mitchell, William	M.S.	1789		Morton
Moberg, Peter	M.A.	1784		Sweden
Moffat, Thomas	M.S./N.S.	1799		
Monro, George	M.S.	1785		Delaware State
Monteiro,Clemente Lourenço	M.S.	1794		Portugal
Moores, Daniel		1786		Maryland
Morison, Alexander	M.S.	1795		Edinburgh
Morse, George	Ph.S.	1800		Norwich
Morton, James	Ph.S.	1784		
Morton, [?]		1786+		
Moultrie, James	M.S.	1786		East Florida
Muir, Thomas	Th.S.	1793		
Muir, Thomas	Preacher	1791		
Murray, [?]	Ph.S.	1799		Jamaica
Murray, Adam		1800		Berwickshire
Murray, John	M.S.	1789		M.A., Glasgow
Murray, William		1785		
Myers, Levi	M.S.	1786		Charleston, South Carolina
Nairne, William	Esq.	1782		[Lord Dunsinane (Judge Advocate)]
Nansey, Perry	M.S.	1795		Suffolk
Neave, Richard	Ph.S.	1792		London
Neill, James	Printer	1798		Edinburgh
New, John		1792		Bristol
New, John	M.S.	1792		Bristol
Nimmo, Patrick	M.S.	1784		
Niven, Alexander	Preacher	1792		Ayrshire. Archibald Hamilton's tutor.
Ogilvy, Alexander	M.S.	1789		Forfarshire
Ogilvy, James	Ph.S.			Edinburgh
Ogle, Robert	Ph.S.	1799		Newcastle
Oliphant, Alexander	Ph.S.	1795		Edinburgh
Orpen, Thomas Herbert	M.S.	1796		Cork
Oswald, Alexander	Ph.S.	1798		Son of Mr. Oswald of Dunnikeer
Owen, John	M.S.	1798		Annapolis, Maryland
Padon, John	Ph.S.	1797		Edinburgh
Palmes, George	Ph.S./Esq.	1798		York
Park, Mungo	M.S.	1791		Fowlshiels near Selkirk
Parker, Patrick	Teacher	1793		Galloway. Teacher of Mathematics.
Paterson, George [Jr.]		1794		Castle Huntley
Pearson, Richard	M.S.	1784	*	Birmingham
Philips, Robert Elliston	Esq.	1782		Secretary to the Board of Customs.

Pillans, James	Ph.S.	1797		Edinburgh
Pinchard, George	M.S.	1791		Northamptonshire
Pinkerton, James	Esq.	1792		[Broughton Loan?]
Pishchecove, Daniel	Ph.S.	1784		Russia
Playfair, Rev. Mr. John		1782		Edinburgh
Plenderleith, John	Ph.S.	1800		West Lothian
Plunkett, Randal	Ph.S.	1795		Dublin
Pollock, David	L.L.S.	1797		London
Poltoratzky, J.		1783		
Portor, John		1782		Waterford, Ireland
Preston, John	Ph.S.	1782		Ireland
Pryce, Dunbar Hamilton		1783		
Pue, Arthur	M.S.	1796		Baltimore, Maryland
Ramage, George	M.S.	1793		Lauder
Ramsay, Andrew Forbes	M.S.	1799		Apprentice to Mr. B. Bell.
Randolf, Thomas	M.S.	1785/86	*	Virginia
Rathay, Charles	M.S.	1799		Warwickshire
Reid, David	M.S.	1782		Glasgow
Renoüard, Rev. John Henry	A.M. (Cantab)	1795		
Reoch, James	M.S.	1795		Clackmananshire
Rive, Gaspard Charles de la	M.S.	1795		Geneva
Roberts, James Watson	M.S.	1785	*	Antigua
Robertson, Arthur Grant	M.D.	1783		Antigua
Robertson, Henry	M.D.	1800		Edinburgh
Roberson, John	M.S.	1794		Ratho
Roberston, John	Esq.	1794		Edinburgh
Robertson, Robert	M.S.	1791		Ross Shire
Robertson, Robert	M.S.	1796		Prenderguest, Berwickshire
Rodgers, [?]	Preacher	1799		Collesse, Perthshire
Rodgers, John R. B.	M.S.	1785		New York
Rogers, John	Preacher/MA	1793		
Rogerson, John	M.S.	1783		
Rogerson, William	Th.S.	1783		
Ross, George	M.S./Botanist	1792		Montrose
Ruuth, Gustavus		1784		Sweden
Salmon, Thomas Stokes	M.S.	1795		Bristol
Sandford, Rev. Daniel	A.M.(Oxon)	1796	*	Edinburgh
Sands, William John	Ph.S.	1796		Edinburgh
Santos, Domingos Felis los	M.S.	1793		Rio de Janeiro, Brazil. Paid 1.3.0.
Santos, Domingos J. Carvalho los	M.S.	1794		Portugal
Scott, John	Chymist	1783		Edinburgh
Scott, John Nelson	M.S.	1795		Isle of Man
Scully, William	M.S.	1799		Tipperary, Ireland
Scott, Benjamin	M.S.	1795		Brighthelmstone
Shuttleworth, Cornelius	M.S.	1794		Leicestershire
Simonds, Lockhart	M.S.	1791		Edinburgh
Simpson, James	L.L.S.	1797		Son to Mr. Simpson, Minister in Edinburgh.
Simpson, William	M.S.	1792		Derby
Skirving, William	Farmer	1792		Jorry
Slow, David	M.S.	1791		Huntingdon
Smellie, James		1800		Orkney
Smith, Francis	M.S.	1785	*	Staffordshire
Smith, James	Preacher	1795		Edinburgh
Smith, James Edward	M.S.	1782	*	Norwich
Smollet, Tobias		1784		
Smollet, Tobias	Ph.S.	1785		
Smyth, James	M.S.	1796		Maryland
Snow, Thomas	Ph.S.	1800		London
Somerville, William	M.S.	1793	*	Jedburgh

Speed, James	M.S.	1796		Kentucky, America
Spence, John	M.S.	1784		
Spence, John	M.S.	1786		Moffat
Spens, Thomas	M.S.	1784		Edinburgh
Spottiswoode, John [Jr.]	Ph.S.	1795/96+		Spottiswoode
Stag, Bethel	Ph.S.	1794		Ackworth, Yorkshire
Stark, Bolling	M.S.	1798		Norfolk, Virginia
Stedman, [?]	M.S.	1784		
Steele, Andrew	W.S.	1785	*	Edinburgh
Steele, Thomas	M.S.	1784		
Stevenson, Duncan	Ph.S.	1795		Argyllshire
Stevenson, Robert	Ph.S.	1797		Glencross
Stewart, Alexander	M.S.	1795		Perthshire
Stewart, Alexander [Jr.]	L.L.S.	1797		Invernesshire
Stewart, Andrew	Preacher	1796		
Stewart, Archibald Douglas	Ph.S.	1793		Carlowrie, West Lothian
Stewart, Charles	M.S.	1786		Stirlingshire
Stewart, Charles	Writer	1782		Edinburgh
Stewart, Charles		1783		
Stewart, Mathew	Ph.S.	1800		Son of Professor Dugald Stewart.
Stewart, Patrick	L.L.S.	1797		Edinburgh
Stirling, Patrick	Ph.S.	1800		
Stirling, William	Ph.S.	1795		
Stovin, James	M.S.	1782		Yorkshire
Strachan, Francis	W.S.	1796		
Straith, Alexander	M.S.	1789		Banfshire
Stringham, James Sackel	M.S.	1798		New York
Stuart, Charles		1786		Stirlingshire
Stuart, Hon. Charles Francis	Ph.S.	1798		Brother to Lord Blantyre.
Stuart, James [Jr.]	Ph.S.	1793		Duncarn
Stuart, Rev. John	Minister	1782		Luss
Stuart, Kenneth Bruce	Ph.S.	1799		Calcutta. Son to General Stuart.
Stuart, Peter	Preacher	1782		Breadalbane
Stuart, Peter J.	Ph.S.	1799		Calcutta. Son to General Stuart.
Sulivan, Laurence	Ph.S.	1799		London
Sulivan, Stephen	Esq.	1799		
Swallow, Robert	M.S.	1800		Edinburgh
Sylvester, [?]	M.D.	1784		Geneva
Symonds, William	M.S.	1785		Herefordshire
Taylor, [?]		1783		
Taylor, Alexander Falconer	Ph.S.	1798		Musselburgh
Taylor, John	Ph.S.	1798		Edinburgh
Taylor, Robert	M.S.	1792		Bolton, Lancashire
Taylor, William	Ph.S.	1798	*	Edinburgh
Telfer, Archibald	Esq.	1783		Ensign in the late South Fencibles Regiment.
Teleford, Thomas	N.S.	1784		
Tennant, Smithson	M.S.	1782		Yorkshire
Thomas, Nathan	M.S.	1785		Deleware State
Thomson, John	Ph.S.	1799/00	*	Down, Ireland. Nephew to Dr. Gillespie.
Thomson, Andrew	Ph.S.	1784		
Thomson, James	Preacher	1795		Perthshire
Thomson, William	B.A.(Oxon)	1782	*	
Throckmorton, Charles	M.S.	1785		England
Tidyman, Phlip	M.S.	1796		South Carolina
Todd, Francis	Ph.S.	1793		London
Touch, George	Ph.S.	1791		
Towers, James	M.S.	1784		Perthshire
Traill, Thomas Stewart	Ph.S.	1798		Orkney
Traill, William	Ph.S.	1800		Orkney

Trotter, John	Preacher	1782		
Trotter, Captian Thomas	Esq./Soldier	1798		Captain in the Militia.
Turretine, Charles	Ph.S.	1800		Geneva. Great Grandson of the Elder Turretine.
Tweedie, John	Th.S.	1782	*	
Tyce, Charles	M.S.	1796		London
Tytler, James	Ph.S.	1795		Edinburgh
Tytler, William Fraser [Jr.]	Ph.S.	1794		Woodhouselee
Udifonço [?]		1792		Brazil
Udny, John Robert	Ph.S.	1795		Middlesex
Unthank, John[8] [7]	[M.D.]	1784	*	Limerick
Urquhart, David	M.S.	1789		Bengal
Vainy, Edward	M.S.	1792		Wiltshire
Vaughan, James	Ph.S.	1800		London
Vernon, James	M.S.	1795		Jamaica
Vivian, John		1792		Cornwall
Vivian, John	Esq.	1792		Cornwall
Wales, Robert	M.S.	1784		
Walker, David	M.S.	1796		Virginia
Walker, Francis	L.L.S.	1796/97		Edinburgh. Son to Mr. James Walker.
Walker, George	Painter	1798		Edinburgh
Walker, James	Th.S.	1798		Tutor to John and Hugh Hope, sons of Sir Archibald Hope
Walker, John	Preacher	1784		
Walker, Patrick	Ph.S.	1793		Edinburgh
Walker, Patrick	Ph.S.	1794+		Edinburgh
Wallace, James	Th.S.	1793		Dumfrieshire
Walterson, Frederick August	M.D.	1786		Berlin. Physician from Berlin.
Ward, William	M.S.	1798		Leicester
Ward, [John] William	Ph.S.	1799		Son to William Ward [(1750-1823), Viscount Dudley and Ward of Duley]
Wardrop, James	M.S.	1799		Whiteburn, Lithgowshire
Warrender, George	Ph.S.	1797		Oldest son to Sir Peter Warrender.
Wauchope, Andrew [Jr.]	Ph.S.	1793		Niddrie
Wauchope, Ensign John	Ph.S.	1796		Niddrie
Wauchope, William	L.L.S.	1796		Niddrie
Wavell, William	M.S.	1785		London
Watson, John	Ph.S.	1792		Edinburgh
Webb, William	Ph.S.	1793	*	Alton, Hampshire
Weddel, John	M.S.	1782		St. Kitts
Weir, George	M.D.	1793		Edinburgh
Wemys, William	Esq.	1782		Cuttlehill
West, Captain William		1789		
West, Captain		1793		Edinburgh. On his third course.
Whistler, Thomas L.	Surgeon	1796		Dublin
White, Douglas	M.S.	1789		Libberton
White, John	M.S.	1789		Shaftsbury, Dorsetshire
White, Thomas	Ph.S.	1800		Newington
Wightman, John	Preacher	1792		
Wilcocks, John Clifton	Ph.S.	1800		Philadelphia, Pennsylvania
Wilkinson, Abraham	M.S.	1782		London
Williamson, David	L.L.S.	1782		
Williamson, John	Th.S.	1797		Lord Ashburton's Tutor.
Williman, Jacob	Ph.S.	1793		Charleston, South Carolina
Wilson, John		1785		Durham
Wilson, John	Ph.S.	1793		Dundee
Wilson, Joseph Niccols	M.S.	1786		South Carolina

[8] Volume III of PNHS states that he holds an M.D., EUL Da 67, f. 113.

Wilson, [Brouncker?]	M.D.	1784		St. Christophers (West Indies)
Wilson, Somervell	M.S.	1784/85		Edinburgh
Wilson, Thomas		1794		Edinburgh
Wilson, William	Ph.S.	1785		Durham
Wishart, John Henry	M.S.	1799		West Lothian
Wood, Thomas	M.S.	1799		Son to Mr. Thomas Wood, Surgeon in Edinburgh.
Woodley, William		1786		Norfolk
Woodley, William	Ph.S.	1786		Norfolk
Wright, Daniel [Jr.]	Ph.S.	1798		Edinburgh
Wylie, James		1792		Edinburgh
Yates, William	M.S.	1792	*	Liverpool
Yelloby, John	M.S.	1795		Alnwick, Northumberland
Young, John	Esq.	1798	*	Cleish

DISSERTATION BIBLIOGRAPHY

ABBREVIATIONS

Publishers

CP	Clarendon Press
CUP	Cambridge University Press
EUP	Edinburgh University Press
OUP	Oxford University Press
PUP	Princeton University Press
SHP	Science History Publications
UCAP	University of California Press
UCHP	University of Chicago Press

Manuscripts and Collections

AUL	University of Aberdeen Library
BL	British Library
EUL	Edinburgh University Library
EC	Cornelius Elliot's Catalogue of Walker's Library
IL	*Index Librorum* (*1761*) of Walker's Library
GUL	Glasgow University Library
LSL	The Linnean Society of London
NAS	National Archives of Scotland
NLS	National Library of Scotland
OUM	Oxford University Museum
RCPE	Royal College of Physicians Edinburgh

Journals & Dictionaries

AHR	*Agricultural History Review*
Ambix	*Journal for the Society of Alchemy and Chemistry*
AIHS	*Archives internationales d'histoire de sciences*
ANH	*Archives of Natural history*
AS	*Annals of Science*
BBM	*Bulletin of the British Museum (Natural history)*
BJHS	*The British Journal for the History of Science*
ECC	*Eighteenth-Century Life*
EOPL	*Essays and Observations, Physical and Literary*
EPS	*Edinburgh Philosophical Journal*
ESH	*Earth Sciences History*
DNB	*Dictionary of National Biography*
DSB	*Dictionary of Scientific Biography*
HPLS	*History and Philosophy of the Life Sciences,*
HS	*History of Science*
HW	*History Workshop*
HWJ	*History Workshop Journal*
JCE	*Journal of Chemical Education*
JHB	*Journal for the History of Biology*
JHC	*Journal of the History of Collections*
JHG	*Journal of Historical Geography*
JHI	*Journal for the History of Ideas*
JOUGS	*Journal of the Open University Geological Society*
JSBNH	*Journal of the Society for the Bibliography of Natural history*
Lychnos	*Annual of the Swedish History of Science Society*
MH	*Medical History*
MR	*Mineralogical Record*
NDNB	*New Dictionary of National Biography*
NRRSL	*Notes and Records of the Royal Society of London*
PRSE	*Proceedings of the Royal Society of Edinburgh*
PT	*Philosophical Transactions of the Royal Society of London*

PETHSS	*Prize Essays and Transactions of the Highland Society of Scotland*
RSCHG	*Royal Society of Chemistry Historical Group Occasional Papers*
SC	*The Seventeenth Century*
SECC	*Studies in Eighteenth-Century Culture*
SHPS	*Studies in the History and Philosophy of Science*
SVEC	*Studies on Voltaire and the Eighteenth Century*
TBSE	*Transactions of the Botanical Society of Edinburgh*
TEGS	*Transactions of the Edinburgh Geological Society*
TIBG	*Transactions of the Institute of British Geographers*

I. PRIMARY SOURCES

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---------- 'The ingenious reflexions relating to *medical springs* numb. 52, considered. the palpable indications of some *healing* springs remarked; with an account of some such springs in *England*, which do conform to the indications; and of others *obiter*; By Dr. John Beale to the Publisher: which discourses were in n. 56 omitted for want of sufficient room, not without injury to the author, who had disigned these communications for another prop, specifying manifest observations, how terrestrial streams be the gererative cause, both of minerals and metals, and of all the peculiarities of springs: and should have immediately followed p. 1134', *PT*, **5** (1670), 1154-1164.

---------- 'Instances, hints, and applications, relating to a main point, solicited in the *preface* to this the *4th vol*; concerning the use may be made of vaults, deep wells, and cold conservatories, to find out the cause or promote the generation salt, minerals, metals, christal; gems, stones of divers kinds; and helps to conserve long; or to hasten putrefaction, fertility of land, &c. &c. by the same Dr. *Beale*, in another letter to the publisher', *PT*, **4** (1668-69), 1135-1142.

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